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Osmotic theories, with special reference to van't Hoff's law

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Osmotic action is a phenomenon referred to in nearly all text-books on physics, in many works on physical chemistry, and in practically all books which deal with physiological phenomena, whether relating to plant or animal. In these same text-books, whether relating to physics, chemistry, or biology, one will look in vain for a satisfactory explanation of osmotic processes. In fact a variety of definitions will be found, some relating to diffusion merely, some relating to osmosis and diffusion in a general way, some relating to osmosis particularly, but all more or less vague; and, when relating to pressure produced by osmotic action, sometimes confusing and contradictory. Of course, osmotic activities in themselves are physical phenomena purely; but as they bear so important a part in relation to physiological operations, they are dealt with frequently in works on biology. But it is to the physical chemist, perhaps, to whom we must look for more light with respect to the operations underlying osmotic processes.

It is not intended here to go into a history of the subject, yet, in order to understand the question in its relationships, it is necessary to give a few points of a historical nature.

The phenomenon of osmosis, first observed in relation to organisms, crept into the text-books and other books on physics, and was dealt with there in connection with diffusion and dialysis rather than as osmosis merely. In such books we have to read through such terms as colloid and crystalloid before we come to osmosis. As a matter of fact, however, colloid and crystalloid

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have nothing to do with the subject, for* "The law of osmotic pressure holds for all substances no matter what the nature." However, we have to know something of the meaning of these terms before we can interpret the statements and definitions given in the text-books on physics. The following statement † gives a common idea with regard to osmosis: "When liquids or gases force their way through porous septa and mix the diffusion is called osmose." Now this would actually not be osmosis at all unless the septum is porous only to such an extent as will permit, yet hinder to some extent, the passage of the liquid. According to the definition given above, the process is diffusion merely. But since the term "force their way through," is used, we have to conclude that it is not mere diffusion. The definition includes, therefore, something of a contradiction. In the following quotation is given another view of the osmotic action: ‡ "In case of two liquids separated by a porous septum, the liquid which wets the septum the better, passes through the more rapidly." This is intended to imply that the attraction which the septum has for the liquid is the factor including osmose, but this is not true in many cases, as for example in the case of the pig's bladder and thistle-tube experiment. For example, when a little caustic potash has been added to the sugar solution which is placed on one side of the septum, and pure water on the other, the sugar solution, aided by the alkali, wets the membrane more quickly than pure water, yet the water passes through the membrane more readily, and the movement is inward. In fact, the sugar solution does not pass through at all, at least not for a considerable time. Referring to the subject of osmosis, Anthony & Brackett § say "An explanation of these facts follows if we suppose that diffusion of a liquid through a continuous membrane can occur only when the liquid is capable of temporarily uniting with the membrane and forming part of it." From this it appears that the membrane itself is the active agent in the process, and that osmotic pressure is due to the attraction and perhaps chemical action of the membrane.

Enough has been said about the general view of osmotic ac-

*Ostwald, Outlines of general chemistry, 128. 1895.

† Gage & Fessenden, Text-book on physics, 43. 1887.

‡ Appleton, Chemical philosophy, 132. 1897 [ed. 4].

§ Text-book of physics, 106. 1888 [ed. 4].

tion to show that we need more definite statements with regard to the subject. We need to remodel our ideas — if the quotations above can be taken as representative of them — because there is no subject more fundamental, more universal in plant and animal functions, than osmosis. And it is in this connection that we need something more definite than we have. The physiologist is confronted with osmotic phenomena at every turn, and he looks in vain for explanations which will satisfy the conditions he meets. Some theories meet with one condition, but not another.

We regard to osmotic pressure, it should be said that no definite measurements were made of it until Pfeffer * developed an apparatus based in its mechanism on the plant cell, but made of inorganic material, and capable of measuring the pressure set up by osmotic forces. Pfeffer's work was epoch-making in this respect, and practically all development made on osmotic measurements, both theoretical and experimental, has been based on Pfeffer's researches. The apparatus which Pfeffer prepared has been known as the "Pfeffer cell." This cell is composed of a porous earthenware cup like a battery jar, in the walls and bottom of which is a precipitate of copper ferrocyanide. This jar, when plugged and connected with a manometer, can be used to measure the pressure produced by osmotic action of certain given substances. This cell, though easily described, is extremely difficult to make, and in very few laboratories, so far as the writer can learn, has the Pfeffer cell been made to work successfully. Comparatively recently, however, the Pfeffer cell has been improved to a high degree by Morse and colleagues † at Johns Hopkins University, and used with great success on osmotic pressure investigations. The improvement to the Pfeffer cell has been mainly in the matter of extracting the air from the porous jar, and placing the membrane. This is done by means of an electric current which forces the liquid into the wall of the jar. The insertion of the stopper plug is a difficult operation also; in fact, where high pressures are to be recorded, the whole operation is one which requires the greatest care in every detail, and one which taxes the patience of the operator to the utmost. Morse and Frazer succeeded in preparing a

* Osmotische Untersuchungen. 1877.

† Am. Chem. Jour., vols. 26, 28, 34, and others.

cell which sustained a pressure of 31 atmospheres, certainly an enormous pressure. Until the electrical method of arranging the cell was developed, a pressure of no such magnitude had ever been obtained.

Recently there has been prepared a good work on osmotic action and its bearing upon plants, by B. E. Livingston.* While this work covers the ground rather thoroughly, it does not refer to Morse's work, and it holds too strictly to van't Hoff's theory of osmotic pressure. However, Livingston's book is by far the most comprehensive and readable on the subject in the English language to-day.

With regard to the subject of osmotic *pressure*, four names stand out prominently, Pfeffer, Morse, van't Hoff, and de Vries — Pfeffer as the originator of the Pfeffer cell, Morse for the development of the cell for high pressure, van't Hoff for an expression of a theory of osmotic pressure, comparing the solute to a gas, and de Vries for recorded results of relative osmotic pressures in plants. It is mainly in regard to *osmotic pressure* and the theories advanced to explain it, that the present discussion is offered. The theory of van't Hoff is the one most generally accepted at the present time, and the only other one that has been offered is now considered rather old and insufficient The chief objections to both theories are that they do not *explain*, and that, in several cases, they leave much to be desired in regard to several phases of osmotic phenomena. Van't Hoff's theory, when put into simple English, is as follows: "Dissolved substances exert the same pressure in the form of osmotic pressure as they would exert were they gasified, at the same temperature, without change of volume," and this idea has been widely accepted. The main reason for its general acceptance is that it seems to harmonize with certain other well-known physical laws; but van't Hoff himself does not appear to have had any experimental knowledge of the actual pressure which osmotic substances do exert. His law, as well as Ostwald's conclusions with regard to the magnitude of osmotic pressure, was based on Pfeffer's researches, and Pfeffer himself was not able to measure osmotic pressure when such pressure reached a point as high as five or six atmospheres. Pfeffer's work in this regard has

*Livingston, "The rôle of diffusion and osmotic pressure in plants." 1903.

been, in fact, the basis for all modern conceptions of osmotic pressure. His figures have entered into text after text, in both physics and chemistry. The work is now regarded as a classic, and van't Hoff's law gives it an emphasis which will carry it on through time, for many years yet. Now, van't Hoff's law does not explain the *cause* of osmotic pressure, it merely states it, and leaves the explanation to be inferred.

Let us point out some of the most serious objections to van't Hoff's law as it relates to osmotic pressure. It bases its argument, from the experimental side, on Pfeffer's researches and conclusions. These show several weaknesses which seriously affect van't Hoff's theory as well as Pfeffer's own figures. Pfeffer states that the osmotic pressure of cane sugar, when a gram molecular weight is dissolved in a liter volume, is 22.4 atmospheres and this is what it should be theoretically according to van't Hoff's theory. Sugar is not an electrolyte, hence no account is to be taken of dissociation. In looking into Pfeffer's work * to examine minutely the methods, this statement is found: "The same pressure (that is, 22.4 atmos.) must be exerted by a solution of 342 grams of cane sugar in 1 liter of water." Now, he surely could not have meant this as stated, because it is not in accord with some of his own statements, and is certainly not in accord with van't Hoff's law, or any ordinary interpretation of it. Moreover, further on is given, on pp. 146, 147 of Pfeffer's Plant Physiology, one statement referring to solution concentration; "1 gram in 100 c.cm. *of water*," and this refers to a column heading on the preceding page, "Osmotic pressure of 1 gram in 100 c.c. *of solution*." From this it appears as though he regarded the two statements, "dissolved in a liter of water," and "dissolved to a liter of solution" as the same thing. In the phrase "342 grams of cane sugar in one liter of water," we have a concentration quite different from that made by dissolving 342 grams to one liter of solution. The latter is that to which van't Hoff's theory directly applies. Theoretically, 342 grams to 1 liter volume gives 22.4 atmospheres pressure. Now, it may be said that Pfeffer made a mere typographical error, when he said "in 1 liter of water." Of course, neither Pfeffer, van't Hoff, nor Ostwald had ever actually developed a pressure of 22.4 atmospheres. Pfeffer used weaker solutions, and

* Osmotische Untersuchungen, 1877, and Physiology of plants, 1900.

from these he *calculated* what the pressure would be for stronger solutions. Supposing we assume that Pfeffer meant to say "342 grams in 1 liter solution" (and this is the only statement tenable if we are to harmonize it with van't Hoff's theory), we are led to an important conflict with Morse's actual experiment which shows that a solution containing 342 grams of cane sugar per liter (of solution), gives over 31 atmospheres pressure. We then arrive at this paradox — *theoretically*, the pressure should be 22.4 atmospheres; *actually*, it is over 31 atmospheres. This pressure of 31 atmospheres was actually obtained. In fact the pressure was more than this, but the apparatus (osmometer) burst at this enormous pressure, and the pressure may therefore be considered more. They conclude that a pressure of at least 32 atmospheres would result from a volume-normal-solution of cane sugar (342 grams per liter of solution).

The actual difference in volume between a solution made by dissolving 342 grams of cane sugar in one liter of solution, and that made by dissolving 342 grams of it in one liter of water is about 214.4 c.c. In the first case the volume is 1000 c.c. and in the latter the volume is 1214.4 c.c.

The following experiment shows also that the gas-pressure theory is not tenable. Pour a few c.c. of chloroform into a test-tube, then drop into this a crystal of iodine. The chloroform turns red from the dissolved iodine. Now pour very gently on top of this a few c.c. of water, and on top of the water a few c.c. of xylol to which has been previously added a crystal of iodine. The xylol dissolves the iodine and so we have one red liquid on top, and one on the bottom of the water. The water remains clear for days, weeks, and months, showing that none of the iodine passes from either the xylol or the chloroform to the water. According to the gas theory, it should do so. But if we carefully suspend by a wire, a crystal of potassic iodide in the water, then, after a short time, the iodine coloration is seen in the water. Some of the iodine has left one or other, or both neighboring liquids. The explanation of this is that the KI solution *attracts* the molecules of iodine from the other solutions. They are attracted *to* not forced *from*.* Morse gives the following expression which applies to

* Am. Chem. Jour. **34**: 91. 1905.

this: "The determining factor in osmotic pressure is the numerical ratio existing between the molecules of the dissolved substance and of the solvent, rather than the number of molecules of the dissolved substance which are contained in a unit volume of the solution." If we place in a tube the three liquids as above, but instead of pure water we substitute a water solution of iodine with potassic iodide, in a day or two the brownish solution in the center becomes colorless towards both top and bottom, while the chloroform and the xylol have turned reddish, showing that the iodine has passed into these liquids. Now if the dissolved iodine acted as a gas, we should have the water solution becoming lighter-colored, but uniformly so, and not light-colored at each end. When the iodine left the water to pass into the chloroform, other molecules of iodine would replace them from behind, if they were *driven* into the chloroform by "gas-pressure." Several other experiments with the liquids, also with turpentine, xylene, ether, and carbon disulphide have been made with colored substances in solution; and the conclusion reached from observation of these is that the pressure which we call osmotic pressure is due to *attraction*.

The Traube* pellicle affords a further illustration of the case in point. When the lump of $CuCl_2$ is dropped into the solution of potassium ferrocyanide a membrane is formed about the lump. Inside of this membrane is $CuCl_2$ solution, and outside is the ferrocyanide solution. The water is taken in through the membrane and into the $CuCl_2$ solution, thus increasing the volume. The membrane bursts and is immediately repaired. The process is continued with another rupture, and so on. Now, the point of rupture is always at, or near, the top of the sack of $CuCl_2$ solution. The solution of copper chloride is much more dilute at the top, yet, if the theory of "bombardment of molecules" were sound, it should rupture obviously where the molecules are most numerous, which is at the bottom. It can easily be seen that the solution is more dense at the bottom by the deep blue color, and it would naturally be so because of the very slow diffusion of the solute upwards. As has been said, the sack should rupture at the bottom, assuming the "gas-pressure" theory. The reason the sack ruptures at the top—an explanation not necessary, how-

* Described in Pfeffer, Physiology of plants 1: 106. 1900 [trans. by Ewart].

ever, to this discussion — is that the membrane is weaker at the top, owing to the fact that the copper chloride is less dense there, and the consequently less rapid chemical action; and also to the fact that the membrane is not so old at, or near, the top. The phenomena which may be observed in the formation of the Traube pellicle present a strong argument against the "gas-pressure" theory.

Take a glass jar and place in it a bright, well-cleaned piece of zinc, or bright iron, then fill with distilled water, and cover tightly with a bladder parchment as for an osmometer. Now immerse the whole jar in a strong solution of copper sulphate. After a time the zinc (or iron) becomes coated over with a dark brown substance which proves to be copper, or copper oxide. If a similar experiment be made, but without the zinc strip, there is no copper sulphate found in the closed jar, even after a few hours. Now the only reasonable conclusion as to how the copper molecules, or ions, reached the zinc, is that they were *attracted* there by the zinc and not *driven* from behind.

The matter of interpretation, or explanation of the gas-theory as accounting for osmotic pressure, shows perhaps as forcibly as the experiment mentioned, that the theory of gas-pressure is wholly inadequate to the situation. Two or three illustrations of the conclusions reached by those basing their explanations on the "gas-pressure" theory may be given to demonstrate what such theory leads to. Take, for example, the explanation often given of osmotic pressure. Livingston * states it thus:

"The following explanation of osmotic pressure has been given by various authors. The quotation is from Davenport [Experimental Morphology]: 'Upon the side containing the greater number of molecules of salt [solute], fewer water [solvent] molecules will in a given time strike the membrane than upon the other side; and since the number passing through is proportional to the number striking, relatively fewer molecules of water will consequently pass out, and so there will be a resultant flow of water to that side; and if the mass of water is confined, it will exert great pressure.' This explanation is untenable for several reasons. . . . Into this matter it is unnecessary to go farther than to add that osmotic pressure can be demonstrated as readily in solutions occupying less volume than the original solvent as in those occupying more. It is obvious

* The rôle of diffusion and osmotic pressure in plants.

that in the former case there must be a greater number of solvent particles per unit volume than in the pure solvent. Hence if the above explanation can be retained, there should be no osmotic pressure developed in such solution; indeed, it should appear on the side of the pure solvent."

Livingston gives in the book already named a more detailed argument than that quoted above to show the fallacy of the theory offered as explanation of osmotic pressure.

Now Livingston himself offers a theory which is objectionable perhaps to the same degree as that which he so thoroughly refutes. He says, p. 26, the pressure is "due to the bombardment of the walls by the solute particles," and, p. 31, "If there were available a membrane permeable to the solute but impermeable to the solvent, this diffusion tension of the solvent might be directly measured. It would be an osmotic pressure similar to that occasioned by the solute molecules, but of much greater magnitude and in the opposite direction." From this it appears as though both solute and solvent exerted osmotic pressure, and this is due to the "bombardment of the walls." But he says, p. 28, "Osmotic pressure is independent of the solvent and dependent only upon the number of particles of solute." Now the bombardment of the walls *outward* does not account for an *inflow* of water; in fact, it would, if anything, oppose the inflow. But he speaks of an osmotic pressure of the pure solvent. Now if this be so, the inflow would be due to this pressure and not to the bombardment of the walls in the opposite direction. He says, p. 30, "Water molecules pass . . . in both directions" and also "particles of solute hinder the escape of the solvent molecules." Yet, if the solute molecules were *bombarding outward*, there would be a greater tendency for a free course without hindrance for solvent molecules *outward*. From the above, the gist of the idea is that the pressure is due to the bombardment of the walls by the solute, and that water is forced in owing to the bombardment from within, because "The pressure produced by the solvent on one side of the membrane is practically equalled by that on the other side." Yet the crucial point is to account for the inflow of water, and it is not easy to see how water enters when there is no force exerted except a bombardment in the *opposite direction*.

One other illustration of a conclusion arrived at from the gas-pressure theory may be given. The statement has been made that if a solution strong osmotically were placed in a very thin glass flask (such as that used by physicists to demonstrate atmospheric pressure by exhausting the air and causing the flask to collapse), the flask would immediately explode because of the "bombardment of the molecules in solution." The experiment is the best proof of the fallacy of this notion. There is no osmotic pressure whatever in such a case and no explosion either. All these theories fall to the ground when examined closely. Now, it is not the intention here to show the insufficiency of these theories merely. The chief object in writing this discussion is to present a clear and reasonable theory, to explain *osmotic action* and particularly *osmotic pressure;* a theory is valuable only so long as it explains.

The theory proposed here postulates two things: (1) That a membrane can be less permeable to one liquid than to another. (2) That the molecules of all substances which are soluble in a certain solvent have an attraction for the molecules of the solvent and the molecules of the solvent for the substance in solution. In regard to the former of these two postulates, it may be said it is entirely comprehensible that a membrane may permit one body to pass through a pore more readily than another, because of the relative size or shape of pore and molecule, and because of friction offered by the membrane to the passage of the molecule. The second postulate above mentioned refers to a condition so common in nature that it scarcely needs a word of comment. All molecules are probably endowed by nature with this attractive force, but it must not be forgotten that this force operates only at very minute distances. To be more explicit, let us take an example. Choosing the common osmometer having a sugar solution within and water without the pig's bladder membrane; suppose the sugar molecule to be too large to pass through the pores of the bladder, and that these pores are large enough to permit the water molecules to pass with little or no opposition, the molecules of sugar attract the molecules of water and both tend to move toward each other. The sugar molecules are prevented from moving through the membrane, but the water is not, hence there is an *inflow* of water, due to attraction. This attraction, then, is the *force* which

underlies osmotic pressure. The operation tends to show that osmotic pressure is, however, regulated by the character of the membrane, and this character depends upon two things; the size of the pores, and the actual relative attraction which the membrane has for the solvent and for the substance in solution. Osmotic processes are not different from diffusion. The membrane simply *shows this diffusion.*

Now, the actual amount of pressure developed by a substance in solution will obviously depend upon the number of molecules (or ions) in a given volume of the solution, hence any other conditions, such as freezing point or boiling point, which have to do with molecular activities, will not likely be very different from osmotic phenomena. And in this connection, it is easy to realize that such attraction as that postulated for osmotic pressure might very probably be different in one substance from that in another. From this it is easy to account for the high pressure of potassium nitrate as compared with sugar, in equimolecular solutions, *without assuming the dissociation theory.* In this case, there is no necessity for assuming ionization. The cause of the high pressure in one case as compared with that in another, is due to the specific attraction of the molecule of the potassium nitrate, and not to the assumption that there are two bodies or ions of K and NO_3, instead of one KNO_3 body. If we assume the dissociation theory to account for the relatively high pressure of such substances as are called electrolytes, we must ascribe as much attractive force to each ion as to the whole molecule, which is a more unreasonable assumption than to ascribe to one molecule of a different kind a greater attractive force than to that of another. In the former case, we have to say, not that "The whole is greater than its part," but that each part is equal to the whole, which, if not unreasonable, is hovering near it. Jost* alludes to "each free ion having the same osmotic value as the entire molecule." To prove this incorrect, is, of course, not easy, but the burden of proof must rest on those who advance that theory. The dissociation theory itself is without much support, and in physiological problems it gives no light. There are so many physiological operations at variance with it that we need not assume the theory

* Plant physiology, 16. 1907 [Eng. trans.].

of ionization at all. In fact, Jost admits this in the following quotation: "However, botanical investigations on the amount of osmotic pressure are entirely independent of this physical theory." The absorption of soil water by plants is a function which cannot be explained on the gas-pressure theory, but is capable of reasonable explanation on the theory of attraction.

With regard to solutions of two or more substances, the statement is generally made that osmotic pressure is the sum of the individual pressures; quoting from Livingston, p. 29, "The total osmotic pressure of a dilute solution of mixed solutes is the sum of the partial osmotic pressures of the component solutes." But, in some cases, this is not true. If we measure the osmotic pressure of a dilute NaCl solution, and then add some $CaCl_2$ to this solution, there is no increase in osmotic pressure. This has been borne out by Osterhout * in his experiments on plasmolysis which he performed upon certain algae. He applied a NaCl solution to the alga, and brought about plasmolysis. He then added some $CaCl_2$ to a similar solution of NaCl and applied this mixed solution to a similar alga. In this case, the plasmolysis did not occur, although the solution was stronger osmotically. In the matter of determining the osmotic pressure of mixed solutions, very little has so far been done. What has been done, however, seems to show that no one can predict *a priori* just what the sum total pressure of mixed solutions will be. As far as plasmolytic operations have been used to demonstrate relative osmotic pressure, it may be inferred that the specific characters of the substances in solution are the determining factors; and that these may differ with different plants. If, however, we assume the theory proposed here — that of specific attraction — these phenomena are easily explained. In mixed solutions, the various molecules of solutes quite probably exert an attraction upon one another, as well as upon the solvent; and, to some extent at least, it may be supposed that whatever attraction a substance might have when alone in solution, would be modified by the presence of molecules of other solutes. Hence, it is not difficult to account for the modified osmotic pressure of such mixed solutions.

In plant and animal functions, it is mixed solutions mainly

* Bot. Gaz. 46: 54. 1908.

with which we are concerned. The "gas-pressure" theory affords no explanation, while the theory of attraction gives a foundation for reasonable explanations of all such phenomena. Root absorption, as a function of plants, is one which, as far as the text-books are concerned, is explained by the statement that the force causing absorption is osmotic pressure. To apply van't Hoff's "gas-pressure" theory with a view to an explanation of the process is next to impossible, for the osmotic pressure is *within* the cell of the plant, and it is not easy to see how such pressure acting *outward* could cause an *inflow* of water. It should also be considered that we have to account for, not only the inflow of water, but also the inflow of substances in solution. The theory of attraction is quite applicable to these activities, and it furnishes a reasonable explanation from the fact that a disturbance of the content of soil water, by the addition of another solute, may render what the soil contained previously to this addition more (or less) available to the plant; because in the theory here advanced, it is assumed that solutes have an attraction for one another as well as for the solvent. When a solution is saturated, this attraction is practically satisfied; or more explicitly, it is counteracted by the attraction of one molecule for another of its kind in the process of crystallization.

With regard to the relatively high osmotic pressure said to be produced in plant cells, it may be said that the method is founded entirely upon van't Hoff's theory and Pfeffer's calculations; and as employed to estimate such pressure, it is open to serious objection. The method of finding the osmotic pressure in a given cell is to use a solution of known osmotic strength (?), and if this *just* induces plasmolysis, the cell sap of the plant is said to be of equal osmotic pressure. But it has been shown by Osterhout, previously cited, that distilled water may, under certain conditions, bring about plasmolysis; also that the addition of $CaCl_2$ to a solution of NaCl which has produced plasmolysis, will actually restore turgor, although the external solution is now stronger osmotically. Moreover, it is not yet known experimentally just what is the magnitude of the osmotic pressure of most of the solutions which have been used in plasmolysis, hence the conclusions are open to objection.

A word about ionization. The attraction theory does not assume ionization, though not inconsistent with it. Physiological investigation gives no support to the theory of dissociation, and osmotic pressure need not assume it. The strongest argument in favor of dissociation is the electrical conductivity, but the very current brought to bear upon the solution may actually *induce* the condition which, by the ionization theory it is assumed exists there *before* the electrodes are applied. It is not intended here to go into any discussion of the theory of dissociation further than to state that osmosis, or osmotic pressure, does not furnish any data for such theory. Osmosis and osmotic action can be explained fully without the assumption of dissociation or ionization. And these statements are made with full knowledge of the fact that the relatively high pressure of such substances as KNO_3 was taken as one basis for the assumption of dissociation.

The theory of surface tension to account for osmotic pressure has been advanced, but, from the physiological side, it can receive no support. Surface tension is something which depends upon the attraction of the molecules of the solvent for one another, and that only in the most minute distances; and is developed only in a few layers of molecules on the extreme surface. It cannot account for osmotic pressure or other osmotic phenomena.

More recently other theories, more or less directly connected with the attraction theory, have been advanced in opposition to van't Hoff's gas-pressure theory.

Perhaps the most important of these is the discussion offered by Kahlenberg * in which he opposes vigorously the gas-pressure theory. So far, we agree with him thoroughly, but the main point of difference between Kahlenberg's argument and that offered in this discussion lies in the fact that Kahlenberg ascribes to the membrane a large portion of that factor which the attraction theory ascribes to the molecules of solute and solvent.

Some of his experiments, notably that employing the three substances — chloroform, water, and ether — and which he calls a "typical case of osmosis," can scarcely be considered osmosis at all, for it is only a mixing of three liquids possessing varying degrees of solubility for one another. Water in this case would

* Trans. Wisconsin Acad. 15: 209. 1904.

be called the membrane. We cannot follow him so far as this, for in speaking of the membrane, he says, "The substance must be soluble in the membrane." In some of his experiments the membrane was dissolved to some extent by the liquid in contact, but so far as it was soluble, the condition was not "typical osmosis." Solubility of the membrane is not necessary. For instance, if we use parchment paper (butter paper) and two liquids, (1) water, (2) sugar solution, these arranged for an osmometer will give about one third of an atmosphere pressure without extra support. There is no solubility whatever of the membrane in either liquid.

On the other hand, we agree with Kahlenberg in the following (*loc. cit.* 271): "To speak of osmotic pressure of any isolated solution . . . is nonsense." . . . And further, to assume that solutes are polymerized or dissociated in dilute solutions because the osmotic pressures developed by the latter in given cases happen to deviate from values computed from the gas laws is evidently equally unjustifiable practice." We do not differ materially from him with respect to the moving force causing osmotic pressure, excepting in the name he employs; namely, chemical affinity. We think this term not happily chosen because the affinity is purely a *physical* one, and not chemical. There is no chemical change whatever. If there be chemical action involved in the operation thus far, it is not osmosis. From the above statement, it must not be assumed that we undervalue the influence of the membrane as a part of the operation. The membrane is absolutely essential. It is a *sine qua non*, but it is merely a screen between the two liquids.

The gas-pressure theory has also been attacked from another point of view, quoting from Nature **72**: 541: "Batelli and Stefanini have brought forward, however, a number of facts which, if subsequently verified, are likely to prove insuperable objections to its [the van't Hoff law's] validity. . . . It is contended that osmotic pressure is essentially a capillary phenomenon." To what extent this may hold good will depend upon how far the idea of capillarity is carried, and if it is used in its broadest sense, the capillary idea is not far removed from that offered in this discussion —that of *attraction*.

A summary of the salient points of this discussion, and of the experiments involved, presents the following: The chief argu-

ments against the gas-pressure theory are: (1) Morse's experiments with sugar solutions show an osmotic pressure of about 32 atmospheres in a gram-molecular weight per liter solution, when it should, by van't Hoff's law, be only 22.4 or thereabouts. (2) The writer's own experiments with colored solutions of various kinds and with different solvents, also his physiological experiments concerned with absorption and with cell sap. (3) Osterhout's experiments on plasmolysis. (4) Many operations connected with living plants, *e. g.*, the formation of ice (in freezing weather) in the intercellular spaces, the formation of calcium oxalate crystals outside the living cells, and others. (5) The growth of the Traube pellicle. (6) Kahlenberg's experiments and discussions.

The Attraction Theory here proposed is not only in harmony with all the phenomena presented as argument against the gas-pressure theory, but it affords a reasonable explanation in each and every case. This theory is not claimed to be entirely new, for it was used, in part here and there, many years ago, but was never applied generally enough, hence it was not surprising to find van't Hoff's law superseding. But van't Hoff's law shows so many weak points that it cannot be accepted as explanatory of osmotic pressure.

MICHIGAN STATE AGRICULTURAL COLLEGE,
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Some noteworthy Hepaticae from the state of Washington

LOIS CLARK

(WITH PLATE 20)

Although Washington is the smallest of the three Pacific Coast states, it has an area of over sixty-nine thousand square miles and presents a great variety of climatic and physiographic conditions. The Cascade Mountains divide the state into eastern and western Washington. In eastern Washington the climate is hot and dry in the eastern and southern portions, cool and moist in the western and northern, especially along the eastern slopes of the mountains. In western Washington the climate is cool and moist throughout, and the whole region abounds in shaded water courses and extensive forests. The state, therefore, throughout the greater part of its extent, is exceedingly favorable for the growth of a rich hepatic vegetation.

Taking the state as a whole, there is only one small area, the university campus at Seattle, where the Hepaticae have been at all thoroughly collected. Other regions which have received some attention are Paradise Valley on Mount Ranier, Queets River valley and Elwha River valley in the Olympic Mountains, and Stevens Pass in the Cascade Mountains. Elsewhere in western Washington very little has been done, and in eastern Washington the Hepaticae have been still more neglected. In spite of the work to be accomplished before our knowledge of the hepatic flora approaches completion, the writer, from collections already made, has been able to identify 101 species from the state, a number which compares favorably with the 86 species known from California and the 117 species known from British Columbia. The most important of the collections studied were made by Professor O. D. Allen, Mr. A. S. Foster, and Professor T. C. Frye.

Scarcely anything has been published on the Hepaticae of Washington. Underwood's list of 1891 * enumerates 16 species,

* A preliminary list of Pacific Coast Hepaticae. Zoe 1 : 361–367. 1891.

and Roell's list of 1893,* 23 species, no fewer than 19 being additions to Underwood's list. Howe has since reported three more species, Stephani two, and C. Müller, of Freiburg, two, so that 42 species in all have been definitely reported from the state. As noted above, this number has been considerably more than doubled by recent investigations.

The present paper makes no attempt to give a complete account of the species known from the state. It simply calls attention to nine species which are of more than passing interest. These include one species new to science and a new variety of a recently published *Scapania*. Of the remaining species noted four are new to North America and three to the United States, although previously reported from the Canadian provinces.

ASTERELLA LINDENBERGIANA (Corda) Lindb.

Fimbriaria Lindenbergiana Corda; Nees von Esenbeck, Naturg. Europ. Leberm. **4**: 283. 1838.

Fimbriaria Bonjeanii DeNot. Mem. Accad. Torino II. **1**: 335. *f. e.* 1839.

Asterella Bonjeanii Trevis. Rend. Ist. Lomb. Sc. II. **7**: 777. 1874.

Hypenantron Bonjeanii Trevis. Mem. Ist. Lomb. III. **4**: 440. 1877.

Asterella Lindenbergiana Lindb. Musc. Scand. 1. 1879.

Hypenantron Lindenbergianum O. Kuntze, Rev. Gen. **1**: 89. 1891.

On wet soil. Queets River valley and Elwha River valley, Olympic Mountains, at an altitude of 4500 feet, *Frye* (*63*, *71*). New to North America, but widely distributed in Europe although nowhere abundant.

A. Lindenbergiana is one of the larger species of the genus. As Howe † clearly shows, it agrees in this respect and also in general habit with *A. californica* (Hampe) Underw., which is still known from California only. The two species agree also in developing their inflorescences either on the main thallus or on

* Nordamerikanische Laubmoose, Torfmoose, und Lebermoose. Hedwigia **32**: 181–203; 260–309; 334–402. *pl. 9–10.* 1893.

† Mem. Torrey Club **7**: 50. 1899.

its principal divisions, instead of on short ventral branches. *A. Lindenbergiana* may be at once distinguished by its monoicous inflorescence, by its violet-red pseudoperianth, by its dark purple spores, and by its red elaters. In *A. californica* the inflorescence is dioicous, the pseudoperianth is white, and the spores and elaters are yellow. The remaining species of the Pacific Coast, although all monoicous, are considerably smaller than *A. Lindenbergiana*, and in two of them, *A. violacea* (Aust.) Underw. and *A. Bolanderi* (Aust.) Underw., the inflorescences both male and female are borne on short ventral branches. In *A. violacea* the pseudoperianth is usually violet, but the spores and elaters are yellow, becoming brownish with age; in *A. Bolanderi* the pseudoperianth is white and the spores and elaters are yellowish brown. Three other species, *A. fragrans* (Schleich.) Trevis., *A. gracilis* (Web. f.) Underw., and *A. Palmeri* (Aust.) Underw., remain to be considered, all of which agree with *A. Lindenbergiana* in the position of the inflorescences but differ in their white pseudoperianths. *A. fragrans* is further distinguished by the numerous white appendages of the ventral scales, which project far beyond the margin in the apical region; *A. pilosa*, by the yellow spores and elaters; and *A. Palmeri*, by the opaque and dark brown spores and yellow elaters.

PALLAVICINIA BLYTTII (Moerck) Lindb.*

Jungermannia Blyttii Moerck; Hornemann, Fl. Dan. **12**: 6. *pl. 2004*. 1830.

Blyttia Mörkii Nees; G. L. & N. Syn. Hep. 474. 1846.

Moerckia Blyttii Brockmann, Arch. Ver. Freunde Naturg. Mecklenburgs **17**: 190. 1863.

Pallavicinia Blyttii Lindb. Not. Sallsk. F. et Fl. Fenn **9**: 17. 1868.

Calycularia Blyttii Steph. Mem. Herb. Boissier **16**: 6. 1900.

On wet rocks. Near Hume's Glacier, Queets River valley, Olympic Mountains, at an altitude of 5000 feet, *Frye* (*56*). Paradise Valley, Mount Ranier, 5000 feet, *Flett*. New to North America, but widely distributed in Europe in subalpine localities.

The present species bears a strong resemblance to *P. Flotowiana* (Nees) Lindb., which is now known from several widely scat-

* Only a few of the synonyms are here given.

tered stations in North America. It agrees with it also in the structure of the thallus, the thickened median portion of which is usually composed throughout of parenchymatous tissue. In this respect both species differ markedly from *P. Lyellii* (Hook.) S. F. Gray and its immediate allies, in which the thallus is characterized by a median strand of narrow elongated cells, forming a very conspicuous feature of the plant. *P. Blyttii* is a little more robust than *P. Flotowiana* and may be easily distinguished by its golden-yellow rhizoids, by its bluntly lobed archegonial scales, and by the ridges of its spores, which are beset with short and truncate spines. In *P. Flotowiana* the rhizoids are white, the archegonial scales are sharply cleft, and the ridges on the spores are smooth along their margins.

NARDIA BREIDLERI (Limpr.) Lindb.

Alicularia Breidleri Limpr. Jahresb. Schlesisch. Gesells. für vaterl. Cultur **47**: 311. 1880.

Nardia Breidleri Lindb. Medd. Soc. F. et Fl. Fenn. **6**: 252. 1880.

On wet soil. Mount Ranier, at an altitude of 6300 feet, *Allen*. An arctic and alpine species new to North America but widely distributed in Europe and known also from Siberia.

Nardia Breidleri grows in flat, depressed mats close to the snow line and is greenish brown in color. It is much smaller than our other species of the genus and looks at first sight more like a *Cephalozia*. It even agrees with *Cephalozia* in the occasional presence of postical branches, although the branching is typically lateral, as in the other species of *Nardia*. The leaves in *N. Breidleri* are either orbicular or a little broader than long and are also more or less concave. They are often bifid one fourth to one third, with obtuse sinus and rounded lobes, but are sometimes only emarginate at the apex. The leaf-cells, mostly 10–16 μ in diameter, have a smooth cuticle and thin walls destitute of trigones. The underleaves are minute and subulate, although sometimes vaguely bifid. Apparently the closest ally of the species is *N. Geoscyphus* (DeNot.) Lindb., which also may be recorded from Washington. It is considerably larger than *N. Breidleri*, the leaves are much more variable, being sometimes undivided and sometimes variously bifid, and the leaf-cells, which measure 20–30 μ

in diameter, have distinct trigones. It is also paroicous in its inflorescence while *N. Breidleri* is dioicous. In both species the perigynium bears a rudimentary sac at the base, differing in this respect from all our other species of the genus.

Jungermannia Allenii sp. nov.

Brownish green or reddish, growing in tufts: stems 1.5–3 cm. long, 0.15–0.25 mm. in diameter, ascending or suberect, sparingly branched, the branches arising close to the postical end of the line of attachment of the leaves; rhizoids few or wanting, not pigmented: leaves distant to subimbricated, obliquely inserted, somewhat concave, slightly decurrent, oval to subrotund, 1–1.5 mm. long, 0.8–1.35 mm. wide, undivided or slightly emarginate, entire, bordered by a row of more deeply pigmented cells; median leaf-cells from 20–30 μ in diameter, trigones large and distinct, cuticle striolate: underleaves sometimes minute and fugacious, sometimes large and persistent, mostly 20–40 μ in length and bearing numerous hyaline papillae, the large ones occasionally attaining a length of 1 mm., sometimes undivided, sometimes variously bilobed or bifid: inflorescence dioicous. [PLATE 20, FIGURES 1–11.]

On rocks, more or less submerged. Paradise Valley, Mount Ranier, *Allen, Flett.* Professor Allen's specimen, which may be considered the type of the species, is deposited in the herbarium of A. W. Evans, at New Haven, Connecticut.

The specimens examined are all sterile with the exception of a single plant bearing a very immature female inflorescence. On the basis of this plant the species is assumed to be dioicous. Unfortunately in the absence of mature floral organs, the generic position cannot be definitely determined. The reddish pigmentation, which is sometimes very marked, points perhaps to *Nardia* or *Jamesoniella*, but it seems wisest to retain the species in *Jungermannia*, at least for the present. In habit and in size it somewhat resembles *J. cordifolia* Hook., which is not uncommon in Washington, although it has not before been recorded from the state. In this species, however, the pigmentation is never reddish, the leaf-cells are wholly destitute of trigones, and there are no underleaves. In *Nardia compressa* (Hook.) S. F. Gray, with which the new species may also be compared, the two rows of plane or slightly concave leaves are laterally appressed to each other, the cuticle is smooth, and the underleaves are uniformly minute and triangular. The

large underleaves in *J. Allenii* are by no means frequent, many stems failing to show them altogether, yet they constitute a striking feature of the species.

JUNGERMANNIA RIPARIA Tayl.

Jungermannia riparia Tayl. Ann. & Mag. Nat. Hist. **12**: 88. 1843.
Aplozia riparia Dumort. Hep. Europ. 63. 1874.

On rocks. Foothills of Mount Ranier, *Allen*. New to the United States but widely distributed in Europe and already reported from British Columbia.

The closest allies of *J. riparia* are *J. cordifolia*, *J. atrovirens* Schleich., and *J. pumila* With. In some respects it is intermediate between the first two and agrees with them in its dioicous inflorescence. It is considerably smaller than *J. cordifolia* and shows a more prostrate habit, producing an abundance of rhizoids and flagella. Its leaf-cells are also distinct in developing trigones, those of *J. cordifolia* having walls of uniform thickness. When compared with *J. atrovirens*, *J. riparia* is seen to be considerably larger and less deeply pigmented, but the two species are apparently connected by intermediate forms. *J. pumila* can be at once distinguished by its paroicous inflorescence.

HYGROBIELLA LAXIFOLIA (Hook.) Spruce

Jungermannia laxifolia Hook. Brit. Jung. *pl. 59*. 1816.
Gymnocolea laxifolia Dumort. Recueil d'Obs. Jung. 17. 1835.
Cephalozia laxifolia Lindb. Musc. Scand. 3. 1879.
Hygrobiella laxifolia Spruce, On Cephalozia 73. 1882.
Cephalozia Notarisiana Massal. Accad. Sc. Med. Nat. Ferrara 201. 1903.

On wet rocks. Paradise Valley, Mount Ranier, *Frye*. New to the United States, but widely distributed in Europe and already reported in North America from Greenland and Labrador.

Although a small species, *H. laxifolia* exhibits a number of very distinct features. The plants grow in tufts, and the ascending or erect stems develop few or no rhizoids. The branching is lateral, some of the branches being similar to the stem and some flagelliform. The transversely inserted leaves are distinctly complicate and equally bifid for about one third their length with acute

divisions. The underleaves are large and similar to the leaves in the majority of cases, but they are sometimes undivided and sometimes show unequal segments. The leaf-cells are characterized by being more or less elongated, measuring from 40–70 μ in length and from 20–30 μ in width; they have thin walls but more or less distinct trigones. The lateral branches, large underleaves, and elongated leaf-cells should at once separate it from the genus *Cephalozia*, to which some authors have referred it, and there is little probability of confusing it with any other northern genus.

DIPLOPHYLLEIA OBTUSIFOLIA (Hook.) Trevis.

Jungermannia obtusifolia Hook. Brit. Jung. *pl. 26.* 1816.
Diplophyllum obtusifolium Dumort. Recueil d'Obs. Jung. 16. 1835.
Diplophylleia obtusifolia Trevis. Mem. Ist. Lomb. III. **4**: 420. 1877.

On wet rocks. Seattle, *Piper*. New to the United States but previously reported from British Columbia. Widely distributed in Europe.

The present species bears a strong resemblance to the dioicous *D. taxifolia* (Wahl.) Trevis., agreeing with it in its rounded leaf-lobes, and it is possible that the two plants have been more or less confused. It is, however, somewhat smaller, and is especially remarkable for its paroicous inflorescence, the antheridia in all other known species being borne on special branches. In the eastern United States, specimens of the recently described *D. apiculata* Evans used to be referred to *D. obtusifolia*, and it is by no means impossible that the true *D. obtusifolia* may yet be detected east of the Mississippi. *D. apiculata* may at once be distinguished by its sharp-pointed leaf-lobes and autoicous inflorescence. In *D. albicans* (L.) Trevis., which is apparently the most abundant species in Washington, the plants are considerably larger, the inflorescence is dioicous, and the leaf-lobes are marked by median bands of elongated cells, simulating nerves in appearance.

SCAPANIA INTERMEDIA (Husnot) Pearson

Scapania nemorosa, var. *intermedia* Husnot, Hep. Gall. 22. *pl. 3. f. 23.* 1875.
Scapania intermedia Pearson, Hep. British Isles 227. *pl. 91.* 1900.

On damp rocks. Near Hume's Glacier, Queets River valley, Olympic Mountains, at an altitude of 5000 feet, *Frye* (*78*). New to North America but previously known in Europe from France and England. The determination of the Washington specimens was kindly confirmed by Dr. Karl Müller, of Freiburg in Breisgau, Germany, one of the highest authorities on the genus *Scapania*.

According to Dr. Müller* *S. intermedia* is a species of somewhat doubtful validity, occupying a position between *S. umbrosa* (Schrad.) Dumort. and *S. dentata* Dumort. and apparently connected with the latter species by transitional forms. It may be distinguished from *S. umbrosa* by the rounded postical lobes of its leaves and from *S. dentata* by its smaller size, smaller leaf-cells, and rougher cuticle. *S. intermedia* is also closely related to *S. Evansii* Bryhn, a North American species which is still imperfectly known. In *S. Evansii*, however, the leaves are less imbricated, and their lobes are less coarsely dentate.

Scapania paludosa papillosa C. Müll. Frib. var. nov.

Reddish brown or almost black: cuticle of the leaves verruculose on both surfaces, the verruculae circular to elliptical in outline, measuring 4–10 μ in length and about 4 μ in width in middle of lobe but becoming smaller toward the margin, densely crowded, some of the larger cells showing as many as 25 on each surface: in other respects agreeing with the type. [PLATE 20, FIGURES 12–17.]

On wet rocks. Near Hume's Glacier, Queets River valley, Olympic Mountains, *Frye* (*88*). A portion of the type is preserved in the herbarium of A. W. Evans, at New Haven, Connecticut.

In the typical forms of *S. paludosa* C. Müll. Frib., the cuticle is smooth or nearly so, and it was at first thought that the roughened cuticle in the Washington specimens would justify separating them as a distinct species. Unfortunately they are completely sterile and, upon submitting them to Dr. Müller for his opinion, it was suggested that the wisest course would be to describe them provisionally as a new variety, reserving final judgment until more complete material should be available. They agree with characteristic *S. paludosa* in showing strongly decurrent leaf-lobes, with blunt apices and a short more or less arched keel. The decurrent

* Nova Acta Acad. Caes. Leop.-Carol. 83: 117. 1905.

portions of the lobes are especially distinct in the new variety and form a more or less continuous line along the postical aspect of the stem. They agree in this respect with the variety *vogesiaca* C. Müll. Frib., a golden-green form with exceedingly minute verruculae, known only from the Vosges Mountains in Alsace-Lorraine. The typical form of the species, which is also green, has been collected in several localities in New England, where it seems to prefer the edges of small pools in bogs at rather high altitudes. The Washington specimens mark a wide extension of the known range of the species in North America, and it is also widely distributed in Europe.

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Explanation of plate 20

1–11. *Jungermannia Allenii* L. Clark

1. Part of stem, postical view, × 15. 2. Part of stem, antical view, × 15. 3. Part of stem with two branches, postical view, × 15. 4. Leaf, × 15. 5, 6. Underleaves, × 140. 7. Cells from margin of leaf, × 240. 8. Underleaf, × 240. 9, 10. Underleaves, showing papillae, × 140. 11. Cells from middle of leaf, × 240. The figures were drawn from the type specimen.

12–17. *Scapania paludosa papillosa* C. Müll. Frib.

12. Part of stem, antical view, × 15. 13. Part of stem, postical view, × 15. 14. Leaf, antical view, × 34. 15. Leaf, postical view, × 34. 16. Cells from margin of leaf, × 240. 17. Cells from middle of lobe, showing papillae, × 240. The figures were all drawn from the type specimen.

Preliminary notes on the genus Usnea, as represented in New England

R. Heber Howe, Jr.

(with plates 21–23)

There is probably no small genus of Lichenes that seems more puzzling to the student than the genus *Usnea*, nor one over which lichenologists are more uncertain or have more often disagreed. We have only to follow the literature from Linnæus to Tuckerman to see how the status of the species has been continually rearranged, though the genus, so far as I can ascertain, has been monographed but once, in 1799.*

A long study of the plants of this genus in the field, with the assembling of a large collection of specimens, and a comparison of over two thousand examples in other herbaria, has led me to believe that the members of the genus are often determined by a most superficial examination, and that one of the best criteria of Tuckerman's Genera Lichenum (p. 13) — *papillate* or *epapillate* thallus — is left out of the equation in the majority of cases where it could have been applied. I have found numerous instances where examples with a *glabrous* thallus have been placed under *barbata*,† and distinctly *papillate* species labelled both *trichodea* and *longissima*. Superficial comparison is used so generally for the determination of lichens that one specimen, wrongly determined, may be the highway for many more.

The general infertility of the filamentous forms, the wide variety of color, which is greatly affected by age, both during growth and in herbaria, have also helped to lead to the common dilemma.

That in some ways the genus would be more easily understood if revised,‡ there seems little doubt, though the less we tamper with the only American standard to which we can cling, the bet-

* Schrader, H. A. Jour. für Bot. 1 : 42–85, including *Alectoria*.

† See conclusion of paper.

‡ See Zahlbruckner in Engler & Prantl, Nat. Pflanzenfam.

ter — at least while field studies of distribution and of environmental effects are so sorely needed — a much better classification seeming now, with our present knowledge, improbable. Progress is not always indicated by frequent revision or by a multiplicity of names, a factor which I think to-day we are only too prone to forget.

It is true that so many different subspecies and forms of *Usnea barbata* have been described and are recognized that the concept of the typical form has been practically obliterated; but is this necessary? *Barbata* no doubt now stands for a generic, rather than a specific concept in most students' minds. The diagnosis, as given by Tuckerman, is so brief and indefinite that specimens are rarely referred to it, but are placed under one of the forms, which have enlarged the limits of the species to include many untypical specimens.

This state of affairs is not easily remedied. The anterior pagination of *Lichen barbatus* over *L. floridus* in Linnaeus' original description * makes it impossible for us to adopt the perhaps more logical *Lichen floridus* for the type form on which to build,† unless we abandon *L. barbatus*. That intergradation also exists between all forms now classed under *Usnea barbata*, no one can doubt, and I am left, therefore, for the present as Tuckerman probably was, to accept the classification of his Synopsis of 1882, based mainly on Fries, as the only feasible one, and to let my field and laboratory studies elucidate wherever and whenever they can.

The only change that in late years has been made is to raise *florida*, *ceratina*, *dasypoga*, and *plicata* to full species, which, it is true, rids us of the disallowed and absurd quadrinomials, and leaves our taxonomy of the present *barbata* group as follows; *barbata* in this case, perhaps, should have been used to designate a papillate section:

Usnea florida (L.) Web.
Usnea ceratina Ach.
Usnea dasypoga (Ach.) Fr.
Usnea plicata (L.) Web.

* Sp. Pl. 1155, 1156. 1753.

† It was recognized as such by Fries, Lich. Eur. 19. 1831. "Typus speciei est forma *florida*, optime fertilis & fruticulosa."

This raising was done by Herre in a most wholesale fashion; *hirta* and *rubiginea* being included, and though a follower of Zahlbruckner, he raises *plicata* to specific rank, which the latter in Engler & Prantl does not do. All this too, without a reason, except the admission that "the species [are] not always well defined and apparently intergrading." Such revisions only serve to burden, as a rule, the synonymy, and for the present, at least, I am unwilling to abandon Tuckerman, though I believe with further study a more lucid and correct classification can be adopted; and I believe that Herre's, based I suppose on that of Hoffmann, though now seeming somewhat warranted, will prove inadequate, and is not allowable according to the methods now followed in nomenclature.

I have used the life zones in outlining the range of the various species, though no doubt plants adhere less closely to such areas than do the animals, being dependent so largely on substrata and conditions of moisture. But to a surprising degree, a nice relationship is shown by this genus.

The following purely artificial key to the genus as represented in New England may be of some aid in determining the species of this difficult group:

Key

Thallus papillate

1. Terete.
   - A. Erect; apothecia abundant, terminal.
     - Rigid; apothecia middling-sized..... *U. barbata florida.*
     - Subcrustose, strigose, short-branched; apothecia large... [*strigosa*].*
   - B. Erect, rarely subpendulous; apothecia wanting (or very rare).
     - Rigid, generally hirsute, sorediate..... [*hirta*].
     - Rusty red..... [*rubiginea*].
   - C. Subpendulous (maximum length, 30 cm.); apothecia rare or wanting, sessile on main filaments or subterminal.
     - Rigid, coarse; fibrils rectangularly arranged..... *U. barbata.*
   - D. Pendulous (average length, 60 cm.); apothecia (rare or very uncommon as represented in this region).
     - Rigid, coarse; fibrils, if present, rectangularly arranged.. *U. barbata ceratina.*
     - Pliant, slender (except at very base); fibrils rectangularly arranged..... *U. barbata dasypoga.*
     - Pliant, slender; lateral fibrils wanting..... *U. barbata plicata.*

Thallus epapillate

   - E. Lax, slender (average length 30 cm.); fibrils capillaceous; apothecia not common..... *U. trichodea.*

* [] indicates contingent forms for which a name is a burden.

F. Lax, slender, scurfy (maximum length 2 m.); fibrils rectangularly arranged; apothecia wanting.....*U. longissima.*

2. Compressed.

Pitted, lax, slender (average length 60 cm.); fibrils capillaceous; apothecia rare.....*U. cavernosa.*

3. Angular.

Rigid, coarse (maximum length 1 m.); fibrils rectangularly arranged; apothecia rare or wanting.....*U. angulata.*

Family: USNEEI

Genus: USNEA (Dill.) Ach.

USNEA BARBATA (L.) Fr.

This typical form must always include a great variety of individually * developed examples, though never includes *slender* filamentous plants of a pendular length exceeding 25 cm. In all save habit of growth and absence of apothecia (the latter a purely artificial line), it has every characteristic of the following subspecies *florida;* and from undoubted sterile examples of the latter, no line can be drawn. *U. barbata* is not uncommonly hirsute, and sorediate, when it is recognized as the variety *hirta*, along with seemingly sterile examples of the next. It is sometimes dichroic, when it is termed the variety *rubiginea*, though this condition is more common of so-called sterile *florida.*† Plate 21 accompanying this paper illustrates a unique phase which I have been able exactly to duplicate but twice,‡ and shows a curiously naked intermediate condition between *barbata* and *ceratina* (though much nearer the latter), which, if *barbata* is dispensed with, falls naturally under sterile *ceratina*, with fruited plants of which it was in one case growing.

The distribution of the typical form is coextensive with that of *florida*, which is suggestive, except that it is this generally infertile form that is largely restricted to the drier situations throughout New England, exclusive of the upper Canadian zone, where it is certainly only rarely represented. Typical examples are restricted to the Upper Austral zone, being apparently intermediary between *ceratina* of the middle Atlantic states and sterile *florida* of the Transition zone.

* Nylander, Syn. Meth. Lich. 267. 1858-60; "erectus aut pendulus," and "e pluribus constat formis."

† These plants in herbaria have always been difficult of determination, as pressing often makes what was an erect plant *in situ*, appear pendulous.

‡ From South Canterbury, Conn., Plymouth, N. H., and St. Martinsville, La.

USNEA BARBATA FLORIDA (L.) Fr.

This is a distinct and easily recognized subspecies, the tufted thallus rarely if ever attaining a development of over 12 cm. The apothecia reach a diameter of 25 mm.* Infertile conditions are not uncommon, and are abundant if we do not recognize *barbata*, and if we hold that *hirta* and *rubiginea* are merely contingent phases. In the so-called variety *hirta*, with the failure to develop apothecia, due presumably to lack of sufficient moisture, the plant often becomes hirsute (and now blackening with age), and is more or less sprinkled with soredia, the distal portions of the filaments often becoming confluently crusted, or sorediate. But this sorediate condition is not absolutely confined to *florida*, but is present occasionally in all forms,† and the difficulty of recognizing it by a name is at once apparent. No doubt if some of our foliose lichens were not so constant morphologically, the sorediate subspecies now recognized would appear as absurd as in the present instance. The stress of the original separation of this form, it has been said, was laid, as the name would imply, on the hirsute ‡ character, the sorediate condition being of secondary importance.

Rubiginea, plainly, it appears to me, is a case of dichromatism, and in other branches of science, ornithology, for example, dichroic conditions are not invariably named, *i. e.*, *Megascops* [*Otus*] *asio* (L.). Later it will be seen that filamentous forms are occasionally also dichroic, though the fertile *florida* is rarely affected.§ By way of explanation, the dichromatism seems perhaps to be due to some sort of dye that attacks mainly the infertile forms — possibly following up the cortex, and sometimes staining the cottony portions of the medulla outside the indurated cord. This explanation is suggested by the fact that the proximal portions are generally first colored, though this is not always true. The color on the other hand may be due to a morphological change as a result of age,

* Mexican specimen.

† Schaerer, 1839, says of *ceratina* "glabra vel verrucoso-pulverulenta."

‡ See first supposed reference, before Linnaeus' description: Tragus, H., "Muscus arborum villosus incanus," etc.; Schaerer, 1839, defines "verrucoso-pulverulenta, fibrillosa et efibrillosa"; Linnaeus' original description reads: "Lichen filamentosus ramosissimus erectus, tuberculis farinaceis sparsis." *Hirtus* would then seem probably used in the sense of rough.

§ Michaux, A., Flora Boreali-Americana 2: 332. 1819: "minus hirta, rubigineo-rubens; scutellis concoloribus." Sorediate specimens are frequently dichroic.

bringing about a new selective scattering, which seems the most likely solution, as old herbarium specimens become in time rust-red. This dichroic condition is at best very difficult of explanation. My friend Mr. Edward Mallinckrodt, of the Mallinckrodt Chemical Works, writes me in reply to a request of mine to investigate this coloration:

"The color is no doubt due to some change of an organic dye contained in the plant, not to any mineral substances and hence the difficulty in analyzing it, as we are easily able to handle mineral substances but not organic. You are no doubt aware that a good deal has been written upon the subject of red leaves without any consensus of opinion as to the cause, if I am properly informed. If I were sure that at the end of a month or so work on the lichen would lead to definite results, I might take it up although all of our men are pretty busy and outside problems are hardly in order, but as a matter of fact unless your lichen is an exception it contains a number of plant substances, which are pretty closely related and difficult to identify. Even if we got these out we would still be unable to put our finger on this one and say that its behavior in a test-tube accounts for the color change in the plant. The whole trouble is that with organic compounds nature works such extremely obscure changes that the chemist in the laboratory can hardly follow them. Analysis, therefore, is extremely difficult in this case, while comparatively easy in the case of mineral or inorganic products."*

Usnea barbata florida occurs on living deciduous trees, more rarely on conifers (degenerate on other substrata), throughout New England, save, in a broad sense, in the upper Canadian zone. It attains its greatest luxuriance in swamps, or in shaded and moist situations. In such places almost every plant found will be heavily fruited, whereas in drier localities only a few plants comparatively will bear apothecia, giving us proof that the remaining plants are sterile examples of *florida*, and should not be classed under a separate species, or even subspecies.

USNEA BARBATA FLORIDA (L.) Fr., f. STRIGOSA Ach.

This form, not recognized in Tuckerman's Synopsis of 1882, but included in the one of 1848, is a contingent form of *florida*,

* See Nylander, *loc. cit.* 265: "Color rubiginosus interdum obviens vix nisi maceratione ortus, nec typicus (inde quoque in *Usnea florida* oritur var. rubiginea Mich., ut animadvertit Eschweiler).

and, so far as I can ascertain, has an approximately coextensive range; from obtainable data, however, it seems to be somewhat littoral, though I have examined specimens from the interior of North America. One from Fayette, Ohio, is dichroic. Some have supposed that *strigosa* represents an aged condition of *florida*, but I do not think that this can be proved. I have observed in the field fresh normal specimens of *florida* in three years grow old and blacken, becoming somewhat ligneous, brittle, and abraded, losing in this way their fibrils and assuming an estrigose appearance, but the short rami, the ample and therefore necessarily crowded apothecia are conditions that certainly in the second instance (short rami) cannot be brought about by age, and are characteristic of certain plants which can be referred only to Acharius' *strigosa*, a form of *florida* which may or may not be worthy of recognition — a form, I believe, that represents only an unusually luxuriant condition, brought about by abundant moisture, such as the littoral examples of the Atlantic seaboard, which are affected by fog, and particularly those seen from Mexico (Hidalgo, over 7,000 feet) and other regions of excessive moisture and luxuriant growth.

USNEA BARBATA CERATINA (Ach.) Schaer.

With the filamentous forms the difficulty of determination is increased threefold,* for immediately a greater similarity seems evident. If we remember, however, that so far we have considered only *papillate* forms, our work is greatly simplified. It is the present subspecies that I feel sure has caused the greatest perplexity in the determination of New England Usneas, for if we accept Schaerer's later diagnosis literally † (see *pl. 1*, Enum. Crit. Lich. 1850), I have seen but three examples of a truly filamentous *Usnea* from these states bearing large or even middling-sized apothecia. There are distributed in herbaria under this subspecies a great many specimens distinctly referable to *barbata* (sterile *florida*), and more often to the following subspecies *dasypoga*. Throwing out the question of "apotheciis magnis," which of course

* The great luxuriance of Pacific coast specimens, due evidently to abundant moisture, if used for comparison, is very misleading.

† Enum. Crit. Lich. Eur. 3. 1850. See also Nylander, Syn. Meth. Lich. 269, "Thallus aut erectus aut pendulus."

only represents a state, the comparative, yet supposedly diagnostic terms, "lax," or "rather lax," are so indefinite as applied to the filamentous forms of this genus that they are really meaningless. In *Alectoria*,* the contrast is sufficient, and eliminates the personal equation.

It is interesting to note that in Tuckerman's Synopsis of 1848 (p. 8) he not only includes the contingent form *strigosa* which he later dropped, but does not include *ceratina* which he later included. It must be remembered that the former work referred to "New England and other Northern States," the region now under consideration, while the work of 1882 considered the lichens of all North America. If *ceratina* occurs in New England, then the statement of Tuckerman (1882), *i. e.*, "apothecia middling to large, rarer in extreme (mountain) forms, which pass into *c*" (= *dasypoga*), must be made at least to read, "rarer in Transition zone where it passes into *c*" (= *dasypoga*) above the Austral zone, and even then it seems we must leave the separation of *ceratina* from the following subspecies to practically the presence or absence of ample apothecia, which would again only emphasize the distinguishing of forms on fertile or sterile states. *Ceratina* no doubt is a rare subspecies in New England, as Tuckerman himself plainly indicates; and of the Tuckerman *Usnea* material that I have examined to date, not a single example has been found and in all the New England material I have examined, but a few examples can be placed here. Willey included it in his New Bedford list, but how typically or commonly represented we do not know, as no annotations are given. I have seen but three fruited specimens from New England, all collected by Miss Cummings at Plymouth, N. H., and all lacking lateral fibrils. Shaerer defined it as "fibrillosa vel efibrillosa," but if we are logical in our taxonomy it would seem that we must either propose a name for this naked condition of *ceratina*, or drop *plicata* as a variety of *dasypoga* (see Engler & Prantl), or recognize naked conditions of both coarse *ceratina* and slender *dasypoga*, under one species *plicata*, which seems distinctly inadvisable.

* Between *A. chalybeiformis* and *A. implexa*.

USNEA BARBATA DASYPOGA Fr.

This subspecies is the pendulous (long on the Pacific coast), filamentous form that reaches 35 or 40 cm. in length. It is the occasional coarseness of the proximal portions of this lichen that has led it to be determined as *ceratina* by many individuals. *U. barbata dasypoga* is common in the high altitudes of the Cana-

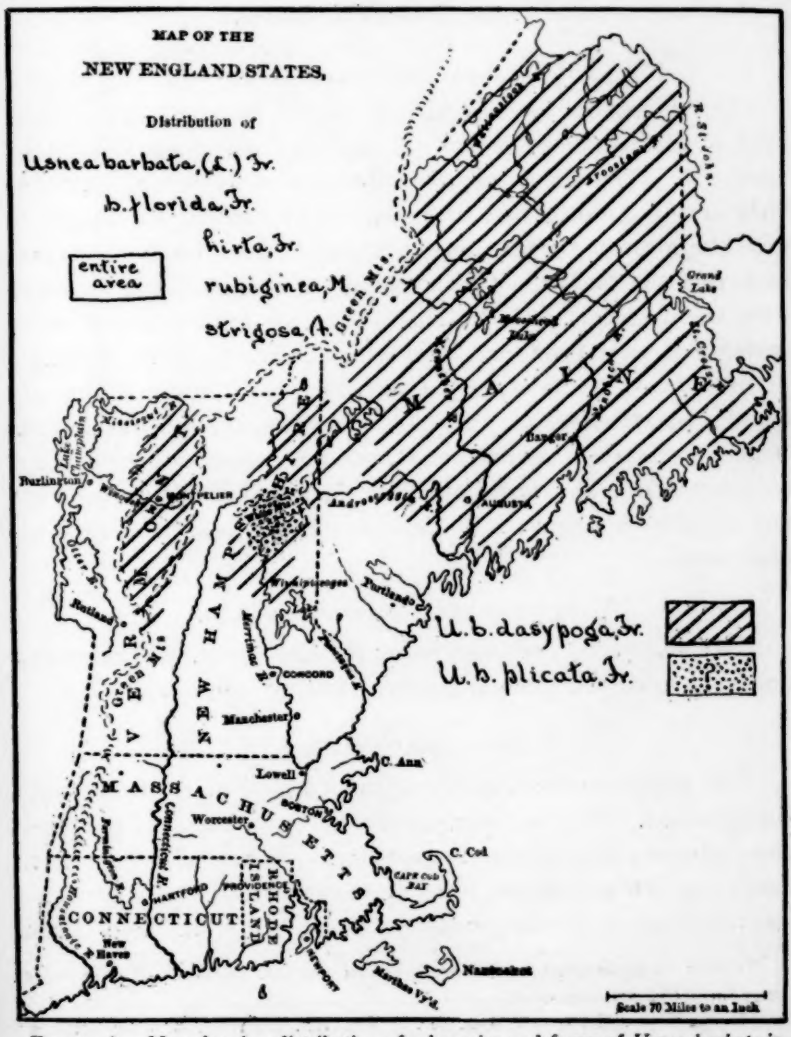

FIGURE A. Map showing distribution of subspecies and forms of *Usnea barbata* in New England.

dian zone, and occurs also in northern Maine, its range being quite similar to that of *U. longissima*. On what grounds Willey included it in his New Bedford list, we cannot tell, as the entry is again without annotation.* There are, however almost Hudsonian "islands" within his area where it could occur, with such species as *Certhia familiaris americana* (Bonap.) and *Parus* [*Penthestes*] *hudsonicus* Forst. Transitional forms between this and the typical *barbata* are common to the Transition regions.

USNEA BARBATA PLICATA Fr.

This subspecies is identical with the last, in regard to slenderness of filamentation, length of thallus, color and scarcity of apothecia. The difference lies in the *lack* of numerous rectangularly arranged fibrils. A specimen determined by Tuckerman † is unlike most of the specimens of recent collection and determination in the herbaria I have examined, and absolutely accords with the diagnosis. Under this subspecies I have found much material of expert determination which in reality is the epapillate *U. trichodea*. The range of *plicata* is held to be, so far as I can ascertain, coextensive with the last subspecies, though this form is evidently much less common and is more northern, being exhibited typically only from Alaska, northern Canada, and Siberia. I have not as yet seen an absolutely typical example from the New England states.

USNEA BARBATA ARTICULATA Ach.

This subspecies does not occur in this region, as Tuckerman implies, or else it is generally overlooked by collectors.

USNEA ANGULATA Ach.

This species in the majority of cases is well marked and easily distinguished. The angular, generally epapillate thallus sometimes attains a length of over one meter. Occasionally a specimen shows but little angulation, being nodulose instead, and approaches *barbata* or one of its subspecies (see specimen in Sull. Moss. Chapt.

* I have since examined the Willey herbarium and find neither subspecies represented by typical specimens.

† In the Taylor Herbarium, Bost. Soc. of Nat. Hist., from British North America; one fibril figured in our PLATE 22.

Herb., *Mrs. L. A. Carter*, Aug. 6, '01, Lake Winnepesaukee, N. H.*). This condition is mentioned by Tuckerman.

U. angulata seems to have a range somewhat coextensive with the following species, *U. trichodea*, though limited more closely to the Austral zone. In fact, it is only poorly developed, as I have observed it, in the Canadian coniferous "islands," where

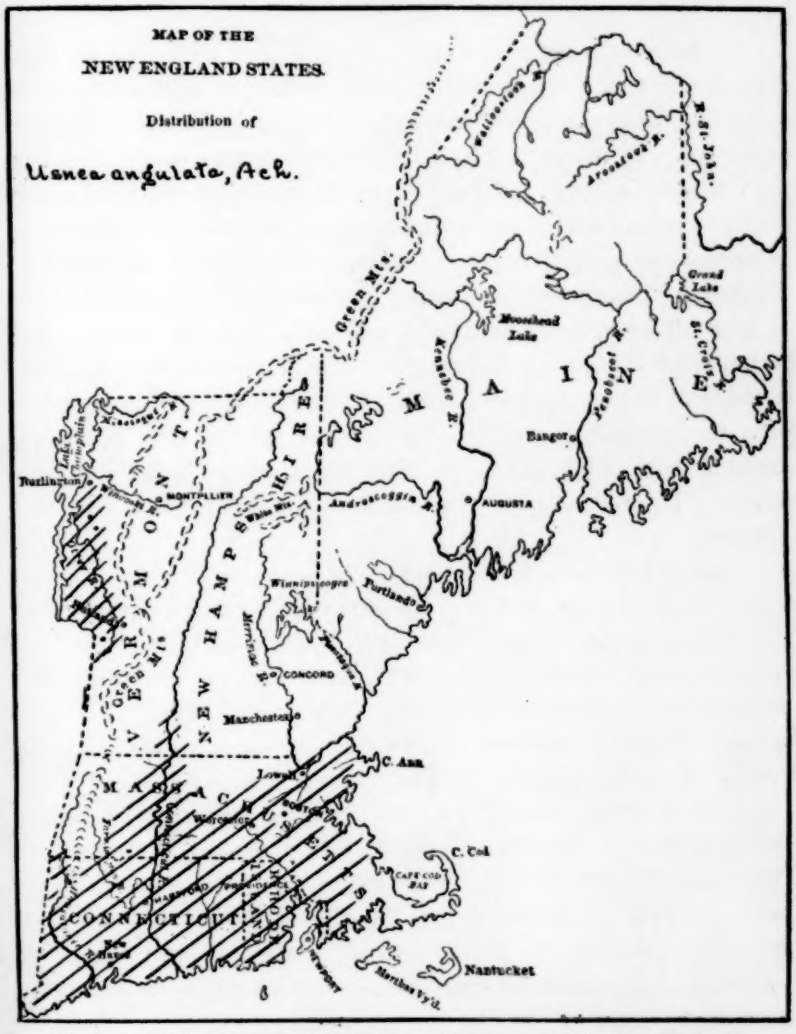

FIGURE B. Map showing distribution of *Usnea angulata* in New England.

* This even suggests *U. cavernosa* Tuck.

trichodea thrives. I have seen no specimens from Marthas Vineyard, but find it commonly, and well represented from Connecticut. Its presence in the Transition zone needs careful establishment. I have examined specimens from Bristol and Monkton, Vt., and one labelled White Mts.; Oakes Collection, in the herbarium of the U. S. National Museum.

USNEA TRICHODEA Ach.

We have now left to consider only the true, *epapillate* species, distinct and easily recognizable. The present, though variable in color, due to age, is *green*, and only in young plants does it appear yellowish. In maturity it is often an even darker shade of green than that of normal *florida*. *U. trichodea* is throughout, a distinctly slender and filamentous species, somewhat suggesting *cavernosa* (with which it is not often confounded) in character of fibrillation, though rarely attaining a pendular length of more than 25 cm. It often bears apothecia, especially near the coast (Cumberland and Hancock counties, Me., and Plymouth, Bristol, Barnstable, and Dukes counties, Mass.), and this helps to distinguish it from the commonly infertile *dasypoga* and *plicata*, which problem the difference of geographical distribution makes largely unnecessary. Though, as has been said, with the latter it is continually confused.

Usnea trichodea is found commonly in the cold cedar swamps of the Austral zone, in fact it appears that its range is somewhat coextensive in the former zone with the Canadian "islands" of *Chamaecyparis thyoides* (L.) B.S.P., and in the latter with the cold swamp "islands" of *Larix*, *Picea*, and *Abies*. In these swamps *trichodea*, however, grows also on various accompanying trees — *Acer*, for example. The unique faunal region of Cape Cod and Marthas Vineyard, where Canadian and Austral faunas are bewilderingly associated, supports this species in abundance. The upper Transition zone or perhaps rarely lower Canadian zone seems to limit its range, except on the coast, where it extends northward certainly as far as Nova Scotia. I have found no specimens collected above 1400 feet. This species is undoubtedly the most common of the filamentous forms.

USNEA LONGISSIMA Ach.

In color this species suggests the last rather than *dasypoga* and *plicata*, though it fades to a yellowish in herbaria much more quickly than does *trichodea*. It is the most pendulous species and a length of nearly four meters has been attributed to it.* Though

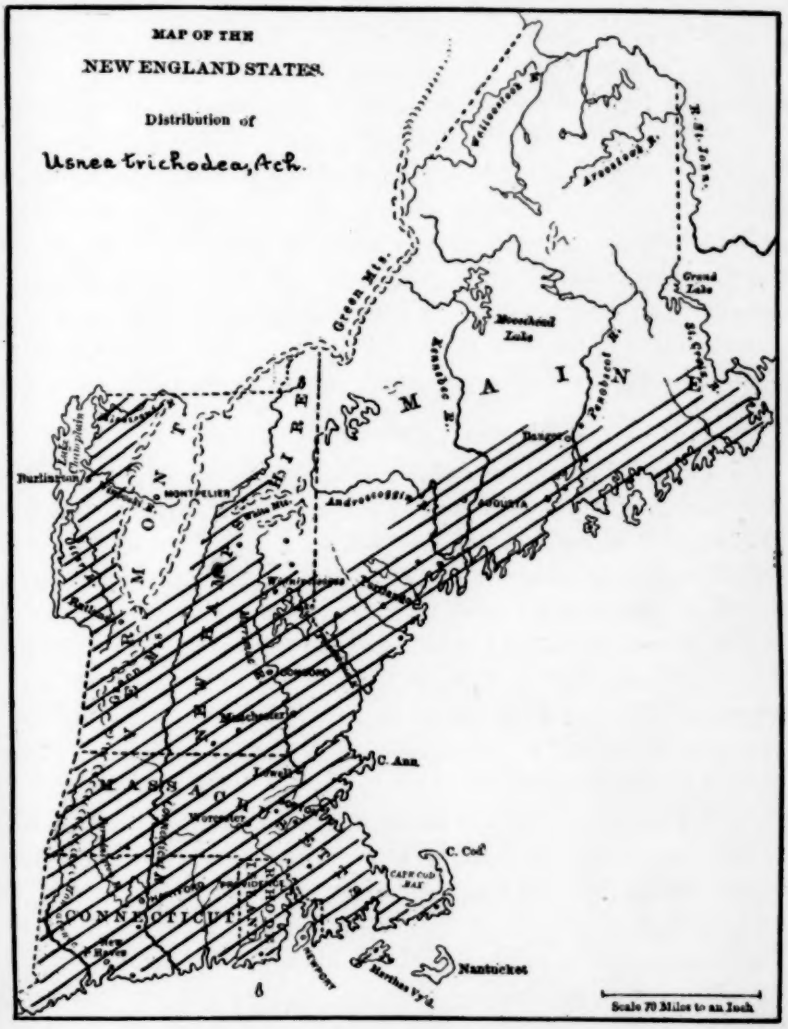

FIGURE C. Map showing the distribution of *Usnea trichodea* in New England.

*See Herre, A. W. C. T. Proc. Wash. Acad. Sci. 7: 345. 1906. This length is never attained, so far as I know, in New England, 3 m. being the maximum recorded.

never bambusaceous or papillate, it is nearly always *scurfy*, the main filaments of the thallus often appearing white, so thickly clothed are they in a furfuraceous crust. This feature is so characteristic and common that it may almost be used as a safe diagnostic character. The fibrillation suggests *angulata*, though the fibrils are of more varying length, of a more slender nature, and are more thickly beset.* Apothecia, so far as I know, have never been observed in New England specimens.

Usnea longissima is a species common to high altitudes, typical of the Canadian zone, which, it will be seen, allows its occurrence in Vermont, New Hampshire, and Maine (excluding the sea-coast in the latter south of Portland). I have examined no specimens collected below an altitude of 1200 feet, except from the Maine coast, where latitude equals altitude and where it is rare and poorly developed. Willey, a contemporary of Tuckerman, did not include it in his New Bedford list, but, of late, specimens from Transition regions have been erroneously determined as *longissima*.

USNEA CAVERNOSA Tuck.

I cannot find any reference to the occurrence of this species in New England other than Tuckerman's statement, "White Mountains," in his Synopsis of 1882 (p. 43). From this we can judge it is a rare member of the genus, perhaps the rarest, that occurs in these states, and that it is confined to the Canadian zone. I have examined but one specimen from this area, collected by Miss Cummings at Plymouth, N. H., March, 1891, and preserved in her herbarium at Wellesley College.† The pitted and compressed thallus of this species is perfectly diagnostic. The fibrillation suggests *trichodea*.

In closing this paper it seems decidedly preposterous for me to question the determinations made in this genus by Miss Clara E. Cummings, and yet I am certain after a most careful study of the genus that if Tuckerman's diagnostic criteria of *papillate* or *epapillate* thallus is valid (along with his other distinctions), and I have found it to be unerring, then no. 83, *Usnea longissima* Ach.,

* This is especially true of tropical and other regions of large rainfall, where it becomes *shaggy*.

† Another specimen (no. *1148* in author's herb.) has lately been received from Dr. Manton Copeland from Brunswick, Maine.

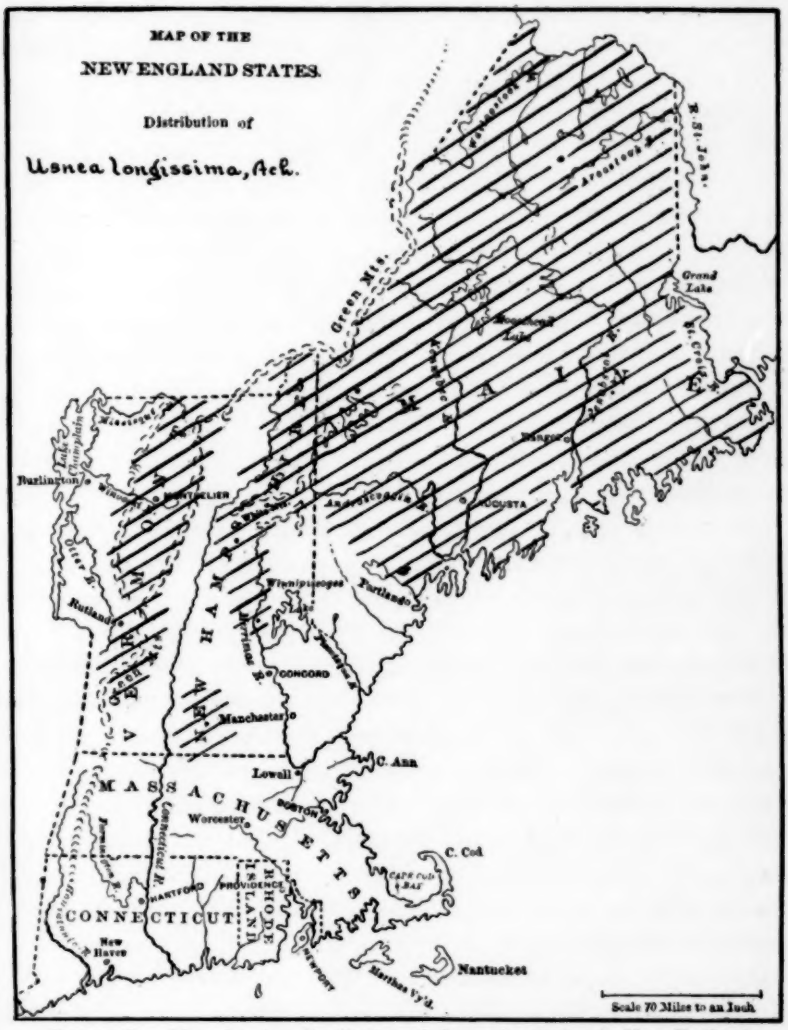

FIGURE D. Map showing distribution of *Usnea longissima* in New England.

in my set of Lichenes Boreali-Americani, second edition, collected at North Woodstock, N. H., August, 1892, by Miss Cummings, must be referred to *Usnea barbata dasypoga* Fr. The specimen distributed in my set is distinctly *papillate*, *not* scurfy in any portion, and not at all characteristically fibrilled. All other nos. 83 of this exsiccati that I have examined contain typical specimens of *longissima*, which would probably prove in this case that an error in

distributing had been made, which is little to be wondered at, considering the enormous pressure of work Miss Cummings struggled with in endeavoring to help others. One specimen, no. 52 of the "Decades," is also correct. With no. 269 of the former distribution, and no. 5 of "Decades" the case is, however, different. These specimens are labelled *Usnea barbata plicata* (L.) Fr.; they are, however, distinctly *epapillate* and untypically fibrilled. Moreover, the locality, Wellesley, Mass., is not within the range of *plicata*, so far as I have observed it or according to Tuckerman, whereas it is a region where *trichodea* is common. It is curious that no. 160 of the "Boreali-Americani" distribution is not only labelled *trichodea*, but contains excellent fruited specimens from Brewster, Mass. This mistake of Miss Cummings only goes to prove the undue stress laid on the presence or absence of apothecia and the difficulty of determining specimens from Tuckerman's meager descriptions in his Synopsis. *U. trichodea* bears apothecia frequently, true *plicata* never or very rarely, and is without lateral fibrils. These two statements are explanatory of Miss Cummings' error. The including of *longissima* from Waltham and *dasypoga* from Natick, in the Flora of Middlesex County, Mass. (1888, p. 166), by Miss Cummings would certainly point to the fact that she believed both species to occur in the region of Wellesley. Feeling as I do, that Miss Cummings, or perhaps one of her aids, in this instance was mistaken, I am sure I have no right, at least, to let the matter go without mention, as I have said before "that one specimen wrongly determined may be the highway for many more," and this is especially true of specimens distributed in well-known exsiccati.

It is my hope to publish within a year or two a manual of North American Usneas, but before this can be done I have yet to examine a great many more specimens from outlying localities not represented in the herbaria I have so far seen, as well as to go over the literature with renewed care. The appended records are taken from all the published New England lists of which I have knowledge, and serve to show how sadly this side of the work has been neglected, and how much is left to be accomplished in the study of distribution. I have examined many of the specimens on which the annotations in these lists were made, as many erro-

neous records have crept in through a misunderstanding of the genus. Let me here enter a plea for more complete data appended to specimens, and a more common publication of authentic local lists, in order that a better study of lichen distribution can be worked out, which I feel sure would help in the labor of taxonomy and broaden our whole knowledge of lichens.

For kind assistance and permission to examine various herbaria I am endebted to Dr. G. M. Allen, Mr. J. A. Cushman, Mr. C. W. Johnson of the Boston Society of Natural History, Dr. N. L. Britton, Dr. M. A. Howe, Dr. J. H. Barnhart, and Mr. R. S. Williams of the New York Botanical Garden, Miss Mary F. Miller of Washington, D. C., Prof. Bruce Fink of Miami University, Dr. Lincoln W. Riddle of Wellesley College, Mr. Fred. LeRoy Sargent of Cambridge, Mr. W. D. Jackson, Bridgewater State Normal School, Mr. Mintin A. Chrysler of the University of Maine, Prof. W. Whitman Bailey and J. Franklin Collins of Brown University, Dr. Manton Copeland of Bowdoin College, Mr. A. H. Norton, of the Portland Society of Natural History, Prof. G. E. Stone of the Massachusetts Agricultural College, Mr. A. S. Goodale of Amherst College, Miss M. A. Day of the Gray Herbarium, Mr. J. S. Galbraith and Prof. S. F. Clarke of Williams College, Mr. Witmer Stone of the Academy of Natural Sciences, Philadelphia, Dr. Alexander W. Evans of the Sheffield Scientific School, New Haven, Conn., Mr. C. C. Plitt of Baltimore, Md., Dr. J. N. Rose of the U. S. National Museum, Washington, D. C., and many others.

Published New England records for the species of *Usnea:*

MAINE. — Harvey, 1894: *florida, hirta, "serotina," dasypoga, plicata:* Orono, *Harvey;* Cumberland, *Blake.*

Harvey, 1894: *longissima:* Greenfield.

Eckfeldt, Wilson, & Cummings (in Rand & Redfield), 1894: *barbata, florida, hirta, rubiginea, ceratina, dasypoga, plicata, trichodea:* Mt. Desert.

Harvey, 1896: *plicata, longissima:* Jackman.

Harvey & Knight, 1897: *plicata, longissima:* Jackman.

NEW HAMPSHIRE. — Howe, 1906: *ceratina* (?): Mt. Monadnock.

Howe, 1908: *florida, hirta, rubiginea, strigosa, dasypoga* (?), *angulata, longissima:* Mt. Monadnock region.

VERMONT. — Frost, 1871 : *barbata, florida, strigosa, rubiginea, hirta, dasypoga :* Brattleboro.

MASSACHUSETTS. — Hitchcock, 1833 : *florida, plicata.*

Hitchcock, 1833 : *strigosa :* Plainfield.

Tuckerman & Frost, 1875 : *barbata, florida, hirta, rubiginea, ceratina, dasypoga :* Amherst.

Sprague, 1880 : *florida, hirta, rubiginea, trichodea.*

Waltham Botanical Club, 1883 : *barbata, florida, strigosa, hirta, longissima :* Waltham.

Cobb, 1887 : *barbata, florida, hirta, rubiginea, ceratina, dasypoga, angulata, trichodea, longissima :* Amherst.

Cummings, 1888 : *florida, hirta, dasypoga, angulata, trichodea longissima :* Middlesex Co.

Willey, 1892 : *barbata, florida, hirta, rubiginea, ceratina, dasypoga, trichodea :* New Bedford.

Howe, 1906 : *rubiginea, ceratina* (?), *strigosa :* Middlesex Co.

Howe, 1903 : *hirta :* Mt. Watatic.

CONNECTICUT. — Hall, 1877 : *barbata, florida, rubiginea, dasypoga, (angulata, Prof. Eaton) :* New Haven.

THOREAU MUSEUM OF NATURAL HISTORY,
CONCORD, MASSACHUSETTS.

Explanation of plates 21-23

PLATE 21

Usnea barbata ceratina collected at South Canterbury, Conn., by Mrs. S. B. Hadley. Very slightly reduced.

PLATE 22

Papillate species

1. *Usnea barbata florida* Fr.

2. *Usnea barbata florida*, f. *strigosa* Ach. Notice short branching and large apothecia.

3. *Usnea barbata florida*, f. *hirta* Fr. Notice hirsute condition and sorediate terminal fibrils.

4. *Usnea barbata ceratina* Schaer. Notice coarse character and frequent presence of apothecia.

5. *Usnea barbata dasypoga* Fr. Notice similarity of fibrillization to that of *U. longissima* Ach. in lower specimen.

6. *Usnea barbata plicata* Fr. Notice almost entire lack of small fibrils (see text).

All slightly reduced in size.

PLATE 23

Epapillate species

1. *Usnea cavernosa* Tuck. Notice similarity of fibrillization to that of *U. trichodea* Ach.

2. *Usnea longissima* Ach. Notice delicateness of main fibril as compared with *U. b. dasypoga* Fr.

3. *Usnea trichodea* Ach. Notice similarity in fibrillization to that of the upper specimen of *U. b. dasypoga* Fr.

4. *Usnea angulata* Ach. Notice similarity of fibrillization to that of *U. b. florida* Fr., intermediate between *U. longissima* Ach. and *U. b. dasypoga* Fr.

New species of fungi

CHARLES HORTON PECK

• Amanita bivolvata

Pileus fleshy, convex or nearly plane, at first viscid, striate on the margin, white, brownish in the center, flesh white; lamellae close, unequal, free, white; stem equal, solid, flocculose, annulate, white, the annulus narrow, often disappearing with age, the volva large, thick, soft, spongy, lobed on the outer margin and having an elevated entire inner margin surrounding the stem; spores subglobose or broadly elliptic, 10–12 μ × 8–10 μ.

Pileus 7–10 cm. broad; stem 13–15 cm. long, 1.6–2.5 cm. thick.

Under oak trees. Claremont, California. January. C. F. Baker.

A large fine white species remarkable for its deep white volva of a soft spongy texture and with a double margin surrounding the base of the stem, the exterior margin of two or three lobes, the interior thin and entire.

Pileus carnosus, convexus subplanusve, primus viscidus, margine striatus, albus, in centro brunnescens, carne alba; lamellae confertae, inaequales, liberae, albae; stipes aequalis, solidus, flocculosus, annulatus, albus, annulo angusto in maturitate saepe evanescente, volva magna, crassa, mollis, spongiosa, margine exteriore lobata, interiore integra; sporae subglobosae vel ellipsoideae, 10–12 μ × 8–10 μ.

Pileus 7–10 cm. latus; stipes 13–15 cm. longus, 1.6–2.5 cm. crassus.

• Amanita calyptratoides

Pileus fleshy, convex, then nearly plane, striate on the margin, covered in the center by a large irregular adhering fragment of the white universal veil or by small fragments formed by the breaking up of the veil, grayish brown or lead-colored or sometimes ochraceous or cream-colored, flesh white, taste mild; lamellae moderately close, unequal, sinuate, adnexed, white; stem nearly equal, hollow, striate at the top, white, the slight evanescent annulus soon disappearing or becoming inconspicuous; spores

often uninucleate, broadly elliptic, 10–12 μ × 6–8 μ, usually with an oblique apiculus at one end.

Pileus 4–8 cm. broad; stem 8–12 cm. long, 8–16 mm. thick.

Under oak trees. Claremont, California. January. C. F. Baker.

This species is allied to *Amanita calyptrata* Peck, from which it is distinguished by its smaller size, darker color with no greenish tints, and by its slight evanescent annulus. Its habitat also is under or near oak trees, while that species occurs under or near fir trees.

Pileus carneus, convexus, demum subplanus, margine striatus, in centro veli universalis candidi fragmento magno aut fragmentis parvis adhaerentibus tectus, ochraceus, cremeus, griseo-brunneus vel plumbeus, carne alba, sapore miti; lamellae subconfertae, inaequales, sinuatae, adnexae, albae; stipes subaequalis, cavus, albus, ad apicem striatus, annulo levi mox evanescente vel inconspicuo; sporae saepe uninucleatae, late ellipsoideae, 10–12 μ × 6–8 μ, vulgo basi apiculatae.

Pileus 4–8 cm. latus; stipes 8–12 cm. longus, 8–16 cm. crassus.

Amanita ocreata

Pileus fleshy, convex or nearly plane, glabrous, even on the margin, white, flesh white; lamellae close, unequal, broadly sinuate, white; stem equal, solid, glabrous or slightly fibrillose below the annulus, minutely floccose above, white, the annulus thin, membranaceous, the volva white, soft, deep with an entire free margin; spores subglobose or elliptic, 10–12 μ × 8–10 μ.

Pileus 4–6 cm. broad; stem 8–10 cm. long, 1–2 cm. thick.

Under oak trees. Claremont, California. January. C. F. Baker.

Pileus carnosus, convexus vel subplanus, glaber, margine levis, candidus, carne alba; lamellae confertae, inaequales, late sinuatae, albae; stipes aequalis, solidus, glaber vel leviter fibrillosus infra annulum, supra minute floccosus, candidus, annulo tenui, membranaceo; volva mollis, candida, margine integro, libero; sporae subglobosae vel ellipsoideae, 10–12 μ × 8–10 μ.

Pileus 4–6 cm. latus; stipes 8–10 cm. longus, 1–2 cm. crassus.

Tricholoma

Armillaria subannulata

Pileus thick, fleshy, convex or broadly convex, subviscid, fibrillose, alutaceous, darker in the center where it is adorned with reddish brown fibrils, margin even, flesh white, odor and taste farinaceous; lamellae close, adnexed, white, sometimes becoming

brown on the edges; stem equal, solid, subradicating, reddish brown, white at the top, veil thick, soft, white, evanescent; spores elliptic, 10–12 μ × 8–9 μ.

Pileus 10–11 cm. broad; stem 9–15 cm. long, 2–3 cm. thick.

Common. Among fallen leaves under oak trees. Claremont, California. January. C. F. Baker.

A large species well marked by its fibrillose pileus, stout stem, evanescent annulus, and farinaceous taste and odor.

Pileus carnosus, convexus vel late convexus, subviscidus, fibrillosus, alutaceus, in centro obscurior ubi fibrillis rufobrunneis ornatus, margine levi, carne alba, odore saporeque farinaceis; lamellae confertae, adnexae, albae, aliquando acie brunnescentes; stipes aequalis, solidus, subradicans, rufobrunneus, ad apicem albus, velo crasso, molli, albo, evanescente; sporae ellipsoideae, 10–12 μ× 8–9 μ.

Pileus 10–11 cm. latus; stipes 9–15 cm. longus, 2–3 cm. crassus.

Clitocybe microspora

Pileus thin, broadly convex or slightly depressed in the center, dry, often eccentric, glabrous or finely and obscurely fibrillose when old, on the margin sometimes irregular or lobed, white or cream-colored, flesh white, odor and taste farinaceous; lamellae thin, close, narrow, unequal, decurrent, white; stem equal, subcartilaginous, hollow, colored like the pileus; spores minute, globose or broadly elliptic, 3–4 μ long.

Pileus 2.5–6 cm. broad; stem 2.5–3 cm. long, 6–8 mm. thick.

Claremont, California. January. C. F. Baker.

Related to *Clitocybe eccentrica* Peck, from which it is separated by its larger size, pileus never umbilicate, lamellae less crowded, stem hollow, and spores smaller.

Pileus tenuis, late convexus seu centro leviter depressus, siccus, saepe eccentricus, glaber vel in maturitate obscure fibrillosus, in margine aliquando irregularis lobatusve, albus vel cremeus, carne alba, sapore et odore farinaceis; lamellae tenues, confertae, angustae, inaequales, decurrentes, albae; stipes aequalis, subcartilagineus, cavus, albus; sporae globosae vel late ellipsoideae, 3–4 μ longae.

Clitocybe sphaerospora

Pileus fleshy, nearly plane, centrally depressed when old, glabrous, opaque, brick-red, darker in the center, flesh tough, white, no distinct taste or odor; lamellae subdistant, narrowed toward each end, decurrent, white, interspaces somewhat venose;

stem equal, slightly radicating, solid, white; spores globose, 10–12 μ broad.

Pileus 5.5–7 cm. broad; stem 5–6.5 cm. long, 1.5–2 cm. thick.

Under oaks. Claremont, California. January. C. F. Baker.

A species belonging to section *Disciformes*, tribe 2, and well marked by its reddish pileus, solid stem, and large globose spores.

Pileus carneus, subplanus, in maturitate centro depressus, glaber, lateritius, centro obscurior, carne lenta, alba; lamellae subdistantes, utrinque angustatae, decurrentes, albae, interstitiis subvenosis; stipes aequalis, subradicans, solidus, albus; sporae globosae, 10–12 μ latae.

Pileus 5.5–7 cm. latus; stipes 5–6.5 cm. longus, 1.5 cm. crassus.

Leptonia flavobrunnea

Pileus thin, fragile, convex, umbilicate or centrally depressed, decurved on the margin, sometimes becoming nearly plane, minutely tomentose in the center, subhygrophanous, dark brown or reddish brown when young and moist, yellowish brown when dry, taste slightly farinaceous; lamellae adnate or subdecurrent, somewhat close, pale lemon-yellow becoming reddish ochre or pinkish, sometimes transversely venose; stem slender, fragile, flexuous, terete or compressed, stuffed or hollow, glabrous, fibrous, pallid or lemon-yellow, becoming brownish yellow, often curved and white at the base; spores subglobose, angular, uninucleate, obliquely apiculate at one end, 8 μ.

Pileus 10–25 mm. broad; stem 5–7.5 cm. long, 2–3 mm. thick.

Gregarious. In swamps under deciduous trees. Stow, Massachusetts. August. S. Davis & G. E. Morris.

Pileus convexus, tenuis, fragilis, umbilicatus vel centro depressus, margine decurvus, quondam subplanus, centro minute tomentosus, subhygrophanus, rufo-brunneus juveno et humido, flavo-brunneus sicco, sapore leviter farinaceo; lamellae adnatae seu subdecurrentes, subconfertae, citrinae, demum roseolae, aliquando transverse venosae; stipes gracilis, fragilis, flexuosus, teres compressusve, farctus cavusve, glaber, fibrosus, pallidus citrinusve, deinde brunneo-luteus, saepe basi curvus et albus; sporae subglobosae, angulares, uninucleatae, oblique apiculatae, 8 μ.

Inocybe Bakeri

Pileus fleshy, broadly convex, becoming nearly plane, dry, densely fibrillose, yellowish or tan-colored, flesh white; lamellae

close, adnexed, subventricose, pale brown, ferruginous brown when mature; stem nearly equal, solid, slender, glabrous, mealy at the top, becoming striate, more or less radicating, white; spores ferruginous-brown, 12–14 μ × 6–7 μ; cystidia 40–50 μ long.

Pileus 2.5–5.5 cm. broad; stem 5–8 cm. long, 5–6 mm. thick.

Under oak trees. Claremont, California. January. C. F. Baker.

Related to *I. sambucina* Fr. but separated by its smaller size, larger, and more slender stem, and the absence of any strong odor. Belongs to the tribe *Velutini*.

Pileus carneus, late convexus, demum subplanus, siccus, dense fibrillosus, cremoreus vel subalutaceus, carne alba; lamellae confertae, adnexae, subventricosae, pallido-brunneae, deinde ferrugineo-brunneae; stipes subaequalis, solidus, gracilis, glaber, ad apicem albo-farinosus, demum striatus, subradicans, albus; sporae ferrugineo-brunneae, 12–14 μ × 6–7 μ; cystidia 40–50 μ longa.

Pileus 2.5–5.5 cm. latus; stipes 5–8 cm. longus, 5–6 mm. crassus.

Inocybe bulbosa

Pileus fleshy, nearly plane, subumbonate, dry, radiately fibrillose, slightly rimose, tan-colored or ochraceous; lamellae thin, close, broadly sinuate, pale buff, becoming brownish ochraceous; stem straight, glabrous, solid, bulbous at the base, cream-colored; spores oblong, even, 10–18 μ × 6–7 μ; cystidia subcylindric, 60–80 μ × 15–20 μ.

Pileus 3–4.5 cm. broad; stem 5–7 cm. long, 7–9 mm. thick, the bulb 15–17 mm. in diameter.

Under oak trees. Solitary. Claremont, California. February. C. F. Baker.

This species belongs to the section *Rimosae* and is related to *I. rimosa* (Bull.) Fr., but it is a larger species with a more expanded and less distinctly rimose pileus, more strongly bulbous stem, and larger cystidia.

Pileus carneus, subplanus, subumbonatus, siccus, fibrillosus, leviter rimosus, alutaceus ochraceusve; lamellae tenues, confertae, late sinuatae, luteolae, demum brunneo-ochraceae; stipes rectus, solidus, glaber, basi bulbosus, pallidus; sporae leves, oblongae, 10–18 μ × 6–7 μ; cystidia subcylindracea, 60–80 μ × 15–20 μ.

Pileus 3–4.5 cm. latus; stipes 5–7 cm. longus, 7–9 mm. crassus, bulbus 15–17 mm. latus.

Flammula praecox

Pileus fleshy, convex, becoming nearly plane, glabrous, moist or hygrophanous, brown or reddish brown, paler when old and dry, sometimes with a dull greenish tint, margin at first involute, flesh pallid; lamellae rather close, adnate or sometimes slightly rounded behind, pale ochraceous becoming brownish ochraceous, whitish and minutely crenulate or eroded on the edge; stem equal or slightly tapering upward, becoming hollow with age, silky-fibrillose, slightly floccose or furfuraceous at the top when young by the pure white slight and evanescent veil, pallid, with a soft white tomentum at the base; spores subochraceous, ellipsoid, 7–8 μ × 4–5 μ.

Pileus 2–3 cm. broad; stem 2–4 cm. long, 4–6 mm. thick.

Gregarious or cespitose. On decaying wood, bark, or branches of deciduous trees, commonly basswood, *Tilia americana* L., or even on dead herbaceous stems. Rockville, Indiana. February and March. G. T. Howell.

Remarkable for its early appearance. It apparently belongs to the tribe *Sapinei* but the color of the young lamellae is uncertain.

Pileus carneus, convexus, demum subplanus, glaber, hygrophanus, brunneus, deinde pallido-brunneus vel rufo-brunneus, aliquando viride tinctus, primo margine involuto, carne pallida; lamellae subconfertae adnatae, aliquando adnexae, pallido-ochraceae, demum brunneo-ochraceae, acie albidae, crenulatae vel erosae; stipes aequalis vel sursum leviter attenuatus, demum fistulosus, sericeo-fibrillosus, in juventate ad apicem leviter floccosus vel furfuraceus velo candido evanescente, pallidus, basi tomento molli candido; sporae subochraceae, ellipsoidae, 7–8 μ × 4–5 μ.

Pileus 2–3 cm. latus; stipes 2–4 cm. longus, 4–6 mm. crassus.

Naucoria vinicolor

Pileus broadly convex or centrally depressed, glabrous, dry, wine-colored, flesh reddish; lamellae subdistant, broad, adnexed, wine-colored; stem equal, hollow, fibrillose, subbulbous, colored like the pileus; spores elliptic, obtuse at each end, smooth, 8–9 μ × 5–6 μ.

Pileus 2–3 cm. broad; stem 3–5 cm. long, 3–4 mm. thick.

Growing from decaying wood or other vegetable matter in open ground. Claremont, California. January. C. F. Baker.

A peculiar species but well marked by its vinous red color. The base of the stem is often covered by a white tomentum. It belongs to the section *Gymnotae*.

Pileus late convexus vel in centro depressus, glaber, siccus, vinicolor, carne rufescente; lamellae subdistantes, latae, adnexae, vinicolores; stipes aequalis, fistulosus, fibrillosus, subbulbosus, concolor; sporae ellipsoideae, utrinque obtusatae, leves, 8–9 μ × 5–6 μ.

Pileus 2–3 cm. latus; stipes 3–5 cm. longus, 3–4 mm. crassus.

Agaricus bivelatus

Pileus fleshy, thin, broadly convex, radiately fibrillose and floccose, cream-colored slightly tinged with pink, smoky brown in the center; lamellae thin, close, free, pink then seal-brown; stem equal or slightly bulbous, glabrous, shining, white-floccose at the top, stuffed or hollow, cream-colored, with a narrow double annulus which at length disappears; spores subglobose, 5–6 μ × 4–5 μ.

Pileus 4–5 cm. broad; stem 3.5–6 cm. long, 8–11 mm. thick.

Under oaks. Claremont, California. January. C. F. Baker.

A distinct species well marked by its double veil, the outer or lower layer being thin and separable from the upper thicker layer.

Pileus carneus, tenuis, late convexus, radiatim fibrillosus, floccosus, cremeus incarnato leviter tinctus, in centro fumoso-brunneus; lamellae tenues, confertae, liberae, incarnatae demum atro-brunneae; stipes aequalis vel leviter bulbosus, glaber, nitidus, farctus vel fistulosus, cremeus, ad apicem floccis albis, annulo duplici angusto, demum evanescente; sporae subglobosae, 5–6 μ × 4–5 μ.

Pileus 4–5 cm. latus; stipes 3.5–6 cm. longus, 8–11 mm. crassus.

Agaricus subnitens

Pileus fleshy, broadly convex or slightly depressed in the center, densely fibrillose, shining on the margin, cream- or tan-colored, flesh white; lamellae thin, close, free, pink becoming dark brown; stem equal or slightly thickened below, stuffed or hollow, white and fibrillose above, cream-colored and shining below with a finally deciduous brown but white-margined annulus; spores elliptic, purplish brown, 6–8 μ × 4–5 μ.

Pileus 4.5–9.5 cm. broad; stem 8.5–13 cm. long, 1–1.5 cm. thick.

Under oaks. Claremont, California. January. C. F. Baker.

Remarkable for its large annulus, which eventually disappears.

Pileus carneus, late convexus vel in centro leviter depressus, dense fibrillosus, margine nitidus, cremeus alutaceusve; lamellae tenues, confertae, liberae, incarnatae demum atro-brunneae; stipes

aequalis vel leviter infra incrassatus, farctus fistulosusve, supra albus et fibrillosus, infra cremeus et nitidus, annulo crasso, brunneo, margine albo, demum deciduo; sporae ellipsoideae, purpureo-brunneae, 6–8 × 4–5 μ.

Pileus 4.5–9.5 cm. latus; stipes 8.5–13 cm. longus, 1–1.5 mm. crassus.

Hypholoma campanulatum

Pileus thin, campanulate, dry, somewhat shining, glabrous, sometimes slightly appendiculate with fragments of the white veil, ochraceous; lamellae thin, close, nearly free, pale brown becoming dark brown, whitish on the edge; stem long, equal, glabrous, hollow, white or cream-colored with a soft white tomentum at the base; spores blackish brown, elliptic oblong, 8–10 μ × 4–5 μ.

Pileus 3–4 cm. broad; stem 8–13 cm. long, 4–7 mm. thick.

Open ground among shrubs, grass, and weeds. Claremont, California. January. C. F. Baker.

Pileus tenuis, campanulatus, siccus, subnitidus, glaber, aliquando albi veli fragmentis leviter appendiculatus, ochraceus; lamellae tenues, confertae, subliberae, pallido-brunneae, demum atro-brunneae, in acie albidae; stipes longus, aequalis, glaber, fistulosus, albus cremeusve, basi tomento molli albo; sporae oblongae ellipsoideaeve, atro-brunneae, 8–10 μ × 4–5 μ.

Pileus 3–4 cm. latus; stipes 8–13 cm. longus, 4–7 mm. crassus.

Phyllosticta innumerabilis

Spots large, suborbicular, sometimes occupying more than half the leaf, brown, yellowish on the circumference; perithecia hypophyllous, minute, 80–100 μ broad, densely gregarious, very numerous, membranous, orbicular, amber-colored; spores oblong or cylindric, hyaline, 6–8 μ × 1.5–2 μ, sporophores 10–20 μ × 1–1.2 μ.

On living leaves of *Amelanchier*. Fort Niobrara, Nebraska. September. Rev. J. M. Bates.

Maculae magnae, suborbiculares, aliquando folii partem magnam occupantes, brunneae, in margine flavidae; perithecia hypophylla, minuta, 80–100 μ lata, dense gregaria, numerosissima, membranacea, orbicularia, mellea; sporae oblongae vel cylindraceae, hyalinae, 6–8 μ × 1.5–2 μ, sporophoribus 10–20 μ × 1–1.2 μ suffultae.

Phoma platysperma

Perithecia minute, about 0.5 mm. broad, numerous, covered by the epidermis, erumpent, black; spores subglobose or broadly ellipsoid, 10–12 μ × 8–10 μ.

On bark of black willow, *Salix nigra* Marsh. River Forest, Chicago, Illinois. March. E. T. & S. A. Harper.

Perithecia minuta, 0.5 mm. lata, numerosa, epidermide tecta, erumpentia, nigra; sporae subglobosae aut late ellipsoideae, 10–12 μ × 8–10 μ.

Sphaeropsis simillima

Perithecia minute, 0.25–0.33 mm. broad, densely gregarious, rarely 2–4 united in a tuft, erumpent, black; spores elliptic or oblong, obtuse, 20–25 μ × 10–12 μ.

On bark of silver maple, *Acer saccharinum* L. River Forest, Illinois. April. E. T. & S. A. Harper.

The perithecia, being occasionally slightly tufted, show an intimate relationship with the genus *Haplosporella*, but as the simple perithecia are much more numerous than the tufted, the species is here placed in the genus *Sphaeropsis*. The specific name is suggested by the great similarity between this species and *Sphaeropsis fertilis* Peck.

Perithecia minuta, 0.25–0.33 mm. lata, dense gregaria, rare caespitosa, erumpentia, atra; sporae ellipsoideae vel oblongae, obtusae, 20–25 μ × 10–12 μ.

Dothiorella Celastri

Perithecia cespitose, 2–20 in a cluster, commonly crowded, erumpent, black, whitish within, unequal, subcoriaceous, subastomous; tufts 0.5–1 mm. broad; spores broadly elliptic or subglobose, hyaline or subhyaline, 5–8 μ × 4–5 μ.

On dead stems of bitter-sweet, *Celastrus scandens* L. Riverside, Illinois. March. E. T. & S. A. Harper.

In some specimens there appears to be a slight stroma or a few hyphae on which the perithecia are seated. The perithecia are unequal in size and shape.

Perithecia caespitosa, vulgo conferta, erumpentia, inaequalia, subcoriacea, subastomata, atra, intus albida; caespites 0.5–1 mm. lati; sporae late ellipsoideae vel subglobosae, hyalinae subhyalinaeve, 5–8 μ × 4–5 μ.

Diplodina fusispora

Perithecia 0.5–1 mm. broad, densely gregarious, sometimes slightly cespitose, irregular or subglobose, erumpent, black; spores short-fusiform, acute at each end, hyaline, at first simple, then uniseptate, 16–20 μ × 4–5 μ.

On branches of silver maple, *Acer saccharinum* L. River Forest, Illinois. April. E. T. & S. A. Harper.

Perithecia 0.5–1 mm. lata, dense gregaria, aliquando leviter caespitosa, irregularia vel subglobosa, erumpentia, atra; sporae breve fusiformes, utrinque acutae, hyalinae, primo simplices, deinde uniseptatae, 16–20 μ × 4–5 μ.

Myxosporium acerinum

Pustules minute, covered by the epidermis, scattered, grayish; spores oozing out and forming minute whitish dots or masses of unequal size, very large, oblong, often narrowed toward one end, granular within, hyaline, 24–40 μ × 8–12 μ.

On bark of silver maple, *Acer saccharinum* L. River Forest, Illinois. April. E. T. & S. A. Harper.

Acervuli minuti, in cortice nidulantes, sparsi, grisei; sporae exudantes et massas minutas inaequales albidas formantes, maximae, oblongae, saepe infra attenuatae, intus granulares, hyalinae, 24–40 μ × 8–12 μ.

Stagonospora linearis

Perithecia pulvinate or hemispheric, 1–1.5 mm. broad, even or rugulose, erumpent, firm, black, whitish within, often yellowish at the base, seriately arranged; spores straight or slightly curved, subcylindric, subclavate or subfusoid, obtuse at each end, triseptate, hyaline, 40–60 μ × 5–6 μ, supported on slender branching sporophores.

On dead branches of hickory. River Forest, Illinois. January. E. T. & S. A. Harper.

Apparently well marked by the long spores and branched sporophores. The perithecia in the specimens seen are astomous.

Perithecia pulvinata hemisphaericave, 1–1.5 mm. lata, levia rugulosave, erumpentia, firma, atra, intus albida, basi flavescentia, seriatim disposita; sporae rectae vel leviter curvae, utrinque obtusae, triseptatae, subcylindraceae, subclavatae, vel subfusiformes, hyalinae, 40–60 μ × 5–6 μ, sporophoribus gracilibus ramosis suffultae.

Bovistella floridensis

Peridium subglobose, 6–20 mm. broad, flaccid, cortex minutely granular or subpulverulent, brown, soon drying and often forming squamules about the apex, then disappearing and revealing the glabrous whitish inner peridium which opens by a definite circular mouth; sterile base present but compact and scanty; capillitium

of long, slender, branching and intertwined subhyaline threads about equal to the spores in diameter, grayish when freed from the spores and viewed with the naked eye, glebe brown when mature; spores globose, rough, 4–5 μ, pedicel 10–20 μ.

On the college campus, DeFuniak Springs, Florida. G. Clyde Fisher.

Peridium subglobosum, 6–20 mm. latum, flaccidum, cortice minute granulari pulverulentove, brunneo, in siccitate squamulas minutas circum apicem formante, demum evanescente; peridium interius glabrum, albidum, ore rotundo dehiscens, basi sterili parvo; capillitium filamentis longis, gracilibus, ramosis, intricatis, subhyalinis compositum; sporae globosae, asperulae, pedicellatae, 4–5 μ latae; pedicellae 10–20 μ longae.

GEOLOGICAL HALL,
ALBANY, NEW YORK

A new fungus of the swamp cedar

HOWARD J. BANKER

(WITH PLATE 24)

During the past year Mr. W. H. Ballou has discovered a new and interesting fungus which appears to be very destructive to the swamp cedar, *Chamaecyparis thyoides* (L.) B.S.P., of the New Jersey coast. The fungus is parasitic on the cedar and as yet appears to be confined to that species. Its destructive effects on the forest are described and well illustrated in an article in the Scientific American for December 19, 1908.

Mr. Ballou's observations of the work of this fungus have been confined to the region about Forked River, Ocean County, New Jersey, where it seems to have fully established its work of destruction. It is desirable that observations be made as soon as possible throughout the range of this cedar that the origin and progress of the disease may be determined. The plant is likely to escape notice without diligent search. The sporophores are borne high on the tree close to or in the canopy, and from their position, size, coloring, and their tendency to fall away from the deadened wood, they are not readily detected.

I take pleasure in dedicating the species to the discoverer whose persistent work on the swamp cedar has led to the detection of this destructive fungus.

Steccherinum Ballouii sp. nov.

Plant parasitic, perennial, pileate; pileus campanulate to subdimidiate, more or less imbricate, sessile, decurrent on a vertical substratum to pendent from a horizontal substratum, easily separable, 1–4 cm. long, 1–5 cm. wide, often confluent laterally to 10 cm.; surface sulcate-zonate, radiately subrugose, somewhat scrobiculate, sometimes velutinous on younger and more protected parts, often licheniferous on the older parts, dark olive-brown when fresh, drying to gray-brown on older parts, becoming light seal-brown on younger portions toward margin; margin obtuse,

somewhat lobed, seal-brown extending around quite to the hymenial side; substance thin, 1–2 mm., of two layers, the upper harder, somewhat brittle, dark brown, the lower softer, light brown; hyphae of upper portion subrigid, thick-walled, dark-colored, more or less interwoven, having numerous globular guttulate bodies massed among the hyphae, single hypha 3–4 μ wide; hyphae of lower portion thin-walled, subhyaline, more or less parallel, without globular bodies, but with numerous granules scattered among them, single hypha 3–4 μ wide; hymenium colliculose, subfarinaceous under a lens, golden yellow when fresh, fading in drying to a light buff or pale cream-colored; teeth various, coarse, subterete to difform, confluent, papilloid to elongate, usually obtuse, tips sometimes brownish, 1–5 mm. long, 0.5–1 mm. wide, irregularly distributed; spores hyaline, broadly elliptical to subglobose, 7–7.2 μ by 5.5–6.5 μ wide; taste mild, slightly bitter, suggesting old hickory nuts; odor slight, resembling the substratum. [PLATE 24.]

On living *Chamaecyparis thyoides* (L.) B.S.P. at Forked River, Ocean County, New Jersey, *W. H. Ballou*, April 6, 1908. Type specimen in the writer's herbarium.

The plant belongs to the family Hydnaceae, which possesses but few parasitic forms. The only other species positively known to be strictly parasitic is *Echinodontium tinctorium* Ell. & Ev., which also attacks species of the Pinaceae on the Pacific coast. The two fungi possess some strikingly similar characteristics, but it is doubtful if they are congeneric. Both approach the tough woody Polyporaceae more closely than any other of the Hydnaceae and would be readily mistaken for members of that family on casual observation. The present plant suggests especially the genus *Coriolus* and except for Hydnaceous hymenial surface would appear to have closer affinities with this genus than with any of those now included in the Hydnaceae. This statement, however, may be made of two or three other species heretofore referred to the genus *Steccherinum*. It seems best, therefore, to refer this new species for the present to this latter genus.

There has long been a doubt in the writer's mind whether the families of the Agaricales, especially the Thelephoraceae, Hydnaceae, and Polyporaceae, are not distinguished by a very artificial

characteristic in the form of the hymenial surface. The natural lines of cleavage appear in many instances to be at right angles to the present system and to be determined by histological rather than morphological characters.

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Explanation of plate 24

The figure shows one of the plants pendent from a horizontal branch. The base of the branch is to the left. The part of the pileus toward the observer is slightly out of focus in order to bring the teeth of the opposite under side sharply into view. Magnified 1.4 +. The photograph was made by one of my pupils, Paul Collins.

INDEX TO AMERICAN BOTANICAL LITERATURE
(1908)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions their kindness will be appreciated.

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Allison, E. M. Bibliography and history of Colorado botany. Univ. Colorado Studies **6**: 51–76. D 1908.

Baker, H. P. Some forestry problems of the prairies of the Middle West. Proc. Iowa Acad. Sci. **15**: 91–95. 1908.

B[ean], W. J. *Rhus Toxicodendron.* Kew Bull. Misc. Inf. **1908**: 455, 456. D 1908.

Beccari, O. Palmae novae antillanae. Repert. Nov. Spec. **6**: 94–96. 20 N 1908.

Includes 4 new species in *Sabal*, *Thrinax*, and *Coccothrinax* (2).

Brown, H. The hashish plant in Arizona and Mexico. Plant World **11**: 180–183. Au 1908.

Brown, N. E. *Cotyledon lateralis.* [In Decades Kewensis — LI.] Kew Bull. Misc. Inf. **1908**: 447. D 1908.

A new species probably native in Mexico.

Brues, C. T. & B. B. A new fossil grass from the Miocene of Florissant, Colorado. Bull. Wisconsin Nat. Hist. Soc. **6**: 170, 171. O 1908.

Cannon, W. A. A redwood sport. Plant World **11**: 232–234. O 1908.

Cockerell, T. D. A. The fossil flora of Florissant, Colorado. Bull. Am. Mus. Nat. Hist. **24**: 71–110. *pl. 6–10.* 1908.

Includes numerous new species in ferns and flowering plants.

Cowles, H. C. The response of plants to soil and climate. In Salisbury, R. D., Physiography for High Schools, 462–473. *f. 443–447.* New York, 1908.

Demcker, R. Die schönsten und grössten Bäume des nordamerikanischen Waldes. Mitt. Deuts. Dendr. Gesells. **1908**: 166–171. 1908.

Dode, L-A. Notes dendrologiques — VI. Bull. Soc. Dendr. France **1908**: 140–166. 15 My 1908. [Illust.]

Dodds, G. S. Geology and physiography of the mesas. Univ. Colorado Studies **6**: 11–19. D 1908.
In "Studies in mesa and foothill vegetation."

Elmer, A. D. E. A century of new plants. Leafl. Philippine Bot. **1**: 272–359. 25 Ja 1908.

Elmer, A. D. E. A fascicle of South Negros figs. Leafl. Philippine Bot. **2**: 531–551. 23 D 1908.

Elmer, A. D. E. *Gesneraceae* from the Cuernos Mts. Leafl. Philippine Bot. **2**: 553–567. 27 D 1908.

Elmer, A. D. E. Six new *Myrsinaceae.* Leafl. Philippine Bot. **2**: 439–444. 7 N 1908.

Elmer, A. D. E. Six undescribed species of *Macaranga.* Leafl. Philippine Bot. **2**: 427–434. 3 N 1908.

Elmer, A. D. E. Synopsis of *Rubus.* Leafl. Philippine Bot. **2**: 445–462. 23 N 1908.

Elmer, A. D. E. The genus *Itea.* Leafl. Philippine Bot. **2**: 527–529. 16 D 1908.

Elmer, A. D. E. Three score of new plants. Leafl. Philippine Bot. **2**: 463–525. 14 D 1908.

Fawcett, H. S. The viability of weed seeds under different conditions of treatment, and a study of their dormant periods. Proc. Iowa Acad. Sci. **15**: 25–45. 1908.

Fleischer, M. Grundlagen zu einer Monographie der Gattung *Stereohypnum* (Hpe.). Hedwigia **47**: 271–288. *f. 1–8.* 18 My 1908; 289–299. *f. 9–15.* 3 Jl 1908.
Includes notes on West Indian and South American species.

Flett, J. B. The seed plants, ferns, and fern allies, of the higher regions of the Olympic Mountains. Mountaineer **1**: 108–116. N 1908.

Foslie, M. Nye Kalkalger. Kgl. Norske Vid. Selsk. Skr. **1908**[12]: 1–9. 1908.
Includes new American species in *Lithothamnion* and *Goniolithon.*

Foslie, M. *Pliostroma*, a new subgenus of *Melobesia*. Kgl. Norske Vid. Selsk. Skr. **1908** [11]: 1–7. 1908.

Frye, T. C. Thallophytes and bryophytes from the Olympic Mountains. Mountaineer **1**: 117–138. N 1908.

Gagnepain, F. Contribution à la connaissance du genre Polycarpaea Lamk. Jour. de Bot. **21**: 275–280. D 1908.

Ganong, W. F. A laboratory course in plant physiology. i–vi + 1–265. *f. 1–68. 4 pl.* New York, 1908. [Ed. 2.]

Graebner, P. Revision der Voss'schen Coniferen-Nomenklatur. Mitt. Deuts. Dendr. Gesells. **1908**: 66–69. 1908.

Graves, A. H. The morphology of *Ruppia maritima*. Trans. Connecticut Acad. Arts & Sci. **14**: 59–170. *pl. 1–15*. D 1908.

Greene, E. L. *Argemone pleiacantha* Greene. Repert. Nov. Spec. **6**: 161. 31 D 1908.
Native in New Mexico.

Hackel, E. *Gramineae* novae — V. Repert. Nov. Spec. **6**: 153–161. 31 D 1908.
Includes new species in *Paspalum*, *Nassella* (2), *Calamagrostis*, *Eragrostis*, *Melica*, *Poa*, and *Festuca*, from Bolivia.

Harms, H. *Araliaceae*. [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 237, 238. 29 D 1908.
Includes *Pentapanax Ulei* sp. nov.

Harms, H. *Leguminosae*. [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 202–217. 29 D 1908.
Includes 30 new species in *Calliandra* (8), *Mimosa* (7), *Bauhinia*, *Cassia* (3), *Swartzia*, *Sweetia*, *Zornia* (3), *Dalbergia*, *Machaerium*, *Platymiscium*, *Camptosema*, *Galactia*, and *Phaseolus*.

Harshberger, J. W. The directive influence of light on the growth of forest plants. Proc. Acad. Nat. Sci. Philadelphia **60**: 449–451. *pl. 24, 25*. Au 1908.

Heimerl, A. Two new species of *Abronia*. Smithson. Misc. Coll. **52**: 197, 198. 23 D 1908.
Native in western United States.

Hickel, R. Notes pour servir à la détermination pratique des abiétinées. Bull. Soc. Dendr. France **1908**: 201–208. 15 N 1908.

Kauffman, C. H. A contribution to the physiology of the *Saprolegniaceae*, with special reference to the variations of the sexual organs. Ann. Bot. **22**: 361–387. *pl. 23*. Jl 1908.

Koehne, E. Abnorme Früchte von *Juglans nigra* L. Mitt. Deuts. Dendr. Gesells. **1908**: 197–199. 1908. [Illust.]

Kraemer, H., & Sindall, H. E. The microscopical and chemical examination of black pepper. Am. Jour. Pharm. **80**: 1–11. *f. 1–4.* Ja 1908.

Kraemer, H., & Sindall, H. E. The microscopical and chemical examination of commercial ginger. Am. Jour. Pharm. **80**: 303–321. *f. 1–5.* Jl 1908.

Kränzlin, F. *Orchidaceae* novae bolivienses. Repert. Nov. Spec. **6**: 18–23. 1 N 1908.

Includes 9 new species in *Pleurothallis*, *Elleanthus*, *Epidendrum*, *Maxillaria* (2), *Sobralia*, *Epistephium*, and *Stenorhynchus* (2).

Lavoura, A. Maduras e vegetaes uteis do Brazil. Bol. Soc. Nac. Agr. [Brazil] **12**: 8–12. F 1908; 333–338. Au 1908; 449–454. O 1908.

Le Renard, A. Recherches anatomiques sur la tige et la feuille des Sabiacées. Jour. de Bot. **21**: 290–332. D 1908.

Livingston, B. E. A new method for cultures of algae and mosses. Plant World **11**: 183, 184. Au 1908.

Livingston, B. E. The botanical garden at Pisa. Plant World **11**: 156, 157. Jl 1908.

Lloyd, F. E. Methods of vegetative reproduction in guayule and mariola. Plant World **11**: 201–208. *f. 6, 7.* S 1908.

Lloyd, F. E. Some features of the anatomy of guayule (*Parthenium argentatum* Gray). Plant World **11**: 172–179. Au 1908.

Lloyd, F. E. Some seedlings of the desert. Plant World **11**: 154–156. Jl 1908.

MacCallum, W. B. The flowering stalk of the century plant. Plant World **11**: 141–147. *f. 1, 2.* Jl 1908.

MacDougal, D. T. The course of the vegetative seasons in southern Arizona. Plant World **11**: 189–201. *f. 1–5.* S 1908; 217–231. *f. 1–12.* O 1908; 237–249. *f. 1–9.* N 1908; 261–270. *f. 1–4.* D 1908.

MacKay, A. H. Water-rolled weed-balls. Proc. & Trans. Nova Scot. Inst. Sci. **11**: 667–670. 27 Jl 1908. [Illust.]

Magnus, P. Über drei parasitische Pilze Argentiniens. Hedwigia **48**: 147–151. *f. 1–5.* 28 N 1908.

Martin-Lavigne, E. Sur une curieuse formation de thylles dans le bois d'une artocarpée. Jour. de Bot. **21**: 281–286. *f. 1–9.* D 1908.

Mazza, A. Saggio di algologia oceanica. Nuova Notar. **19**: 153–170. O 1908.

Murrill, W. A. *Polyporaceae* (conclusio). N. Am. Flora **9**: 73–131. 12 Mr 1908.

Includes new species in *Coriolopsis* (4), *Cerrenella*, *Inonotus* (3), *Fomes*, *Pyropolyporus* (10), *Amauroderma* (3), *Ganoderma* (11), *Lenzites* (2), and *Gloeophyllum*.

Olive, E. W. Sexual cell fusions and vegetative nuclear divisions in the rusts. Ann. Bot. **22**: 331–360. *pl. 22*. Jl 1908.

Pammel, L. H., & Robb, L. Notes on the histological structure and specific gravity of the seeds of *Pyrus*. Proc. Iowa Acad. Sci. **15**: 47–53. *pl. 1, 2*. 1908.

Pampanini, R. Una specie ed una varieta nuova di *Tithonia* Desf. Bull. Soc. Bot. Ital. **1908**: 132–134. 31 D 1908.

Tithonia Vilmoriniana, native in Mexico.

Pilger, R. Kleinere Beiträge zur Kenntnis der Meeresalgen — I. Hedwigia **48**: 178–183. 28 N 1908.

Includes *Actinococcus exul* and *Nitophyllum Paessleri*, spp. nov. from south Chile.

Ramaley, F. Climatology of the mesas near Boulder, Colorado. Univ. Colorado Studies **6**: 19–31. D 1908.

In "Studies in mesa and foothill vegetation."

Ramaley, F. The botanical opportunity in Colorado. Univ. Colorado Studies **6**: 5–10. D 1908.

Reed, H. S. Fall blossoming of the apple induced by the black rot. Plant World **11**: 256, 257. N 1908.

Rehder, A. Einige neue oder critische Gehölze. Mitt. Deuts. Dendr. Gessels. **1908**: 157–163. 1908.

Reiche, K. Zur Kenntnis der Dioscoreaceen-Gattung *Epipetrum* Phil. Bot. Jahrb. **42**: 178–190. *f. 1–5*. 29 D 1908.

Robbins, W. W. Distribution of the deciduous trees and shrubs on the mesas. Univ. Colorado Studies **6**: 36–49. *f. 1–10*. D 1908.

In "Studies in mesa and foothill vegetation."

Robbins, W. W., & Dodds, G. S. Distribution of conifers on the mesas. Univ. Colorado Studies **6**: 31–36. *f. 1*. D 1908.

In "Studies in mesa and foothill vegetation."

Rose, J. N. A new *Opuntia* from Arizona. Smithson. Misc. Coll. **52**: 153. *pl. 12*. 6 O 1908.

O. vivipara.

Rose, J. N. On *Opuntia Santa-rita*, a species of cactus of ornamental value. Smithson. Misc. Coll. **52**: 195, 196. *pl. 15*. 29 D 1908.

Rosenstock, E. *Filices* novae — IV. Repert. Nov. Spec. **6**: 175–179. 31 D 1908.

Includes 2 new species in *Notochlaena* and *Polypodium*, native in Bolivia.

Saccardo, P. A. Notae mycologicae. Ann. Myc. **6**: 553–569. 31 D 1908.
Includes 19 new American species, 14 from New York and 5 from Mexico.

Sargent, C. S. Das Arnold-Arboretum. Mitt. Deuts. Dendr. Gesells. **1908**: 163–166. 1908. [Illust.]

Sauer, L. W. A key to Ohio's commoner conifers. Plant World **11**: 235–236. O 1908.

Saunders, C. F. Vital tenacity of an orange tree stump. Plant World **11**: 234, 235. O 1908.

Shimek, B. A hybrid oak. Proc. Iowa Acad. Sci. **15**: 77–83. *pl. 1, 2.* 1908.

Shimek, B. The genesis of Loess a problem in plant ecology. Proc. Iowa Acad. Sci. **15**: 57–75. *pl. 3–7.* 1908.

Shreve, F. Transpiration and water storage in *Stelis ophioglossoides* Sw. Plant World **11**: 165–172. Au 1908.

Shull, G. H. Dr. Baur on variegation. Plant World **11**: 147–151. Jl 1908.

Skinner, J. J. Water culture method for experimenting with potatoes. Plant World **11**: 249–254. *f. 10–12.* N 1908.

Spalding, V. M. The western edge of the Colorado Desert. Plant World **11**: 208–215. S 1908.

Sprague, T. A. *Bignoniaceae* peruvianae. Bot. Jahrb. **42**: 177. 29 D 1908.
Includes *Stenolobium arequipense* sp. nov.

Sprague, T. A. *Columnea* (*Eucolumnea*) *guatemalensis.* [In Decades Kewensis — LI.] Kew Bull. Misc. Inf. **1908**: 448. D 1908.
A new species from Guatemala.

Sprague, T. A. *Columnea* (*Eucolumnea*) *oblanceolata.* [In Decades Kewensis — LI.] Kew Bull. Misc. Inf. **1908**: 449. D 1908.
A new species from Costa Rica.

South, F. W., & Compton, R. H. On the anatomy of *Dioon edule* Lindl. New Phytol. **7**: 222–229. *f. 35–40.* 31 D 1908.

Stapf, O. *Angadenia nitida.* Curt. Bot. Mag. **5**: *pl. 8233.* Ja 1909.
Native in tropical South America.

Stiles, W. The anatomy of *Saxegothaea conspicua* Lindl. New Phytol. **7**: 209–222. *f. 28–34.* 31 D 1908.

Stephani, F. Species *Hepaticarum.* Bull. Herb. Boiss. II. **8**: 125–148. 31 Ja 1908; 205–220. 29 F 1908; 267–282. 30 Mr 1908;

371–375. 2 My 1908; 426–436. 30 My 1908; 483–514. 1 Jl 1908; 561–608. 31 Jl 1908; 661–696. 31 Au 1908; 745–776. 30 S 1908; 837–866. 31 O 1908.

Includes new American species in *Chiloscyphus* (4), *Zoopsis*, *Cephalozia* (6), *Alobiella*, *Odontoschisma* (10), *Adelanthus* (2), *Marsupidium*, *Calypogeia* (6), *Mastigobryum* (16), and *Saccogyna* (2).

Stone, R. E. Peculiarities in the known distribution of some species of cedar apple. Plant World **11**: 270–272. D 1908.

Sumstine, D. R. Observations on habits of fungi in western Pennsylvania. Plant World **11**: 274, 276, 277. D 1908.

Svedelius, N. Über den Bau und die Entwicklung der Florideengattung Martensia. Kungl. Svensk. Vet.-Akad. Handl. **43**[7]: 1–101. *pl. 1–4 + f. 1–62.* 19 D 1908.

Urban, I. *Loasaceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 231, 232. 29 D 1908.

Includes *Loasa Gilgiana* sp. nov.

Urban, I. Plantae novae andinae imprimis Weberauerianae — IV (Schluss). Bot. Jahrb. **42**: 177. 29 D 1908.

Includes *Stenolobium arequipense* sp. nov. from Peru. (Sprague.)

Ulbrich, E. *Malvaceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 225–229. 29 D 1908.

Includes 5 new species in *Sida* (2), and *Pavonia* (3).

Ule, E. Beiträge zur Flora von Bahia — I. Bot. Jahrb. **42**: 191–238. *pl. 1 + f. 1.* 29 D 1908.

Includes 10 separate papers indexed under their respective authors as follows, Ule (6), Harms (2), Ulbrich, and Urban.

Ule, E. *Bromeliaceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 191–199. *f. 1.* 29 D 1908.

Includes new species in *Sincoraea* gen. nov., *Cryptanthopsis* gen. nov., *Bromelia*, *Nidularium*, *Hohenbergia* (2), *Aechmea*, *Dyckia*, and *Encholirion* (2).

Ule, E. *Capparidaceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 201, 202. 29 D 1908.

Includes a new genus and three new species.

Ule, E. *Euphorbiaceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 217–225. 29 D 1908.

Includes 4 new species in *Argyrothamnia*, *Plukenetia*, *Pera*, *Jatropha* (3), *Manihot* (2), *Sebastiania* (2), *Stillingia*, and *Euphorbia* (3).

Ule, E. *Loranthaceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 199–201. *pl. 1.* 29 D 1908.

Includes new species, *Struthanthus sincorensis*, *S. tenuicaulis*, and *Phoradendron Caesalpiniae.*

Ule, E. *Melastomataceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 232–236. 29 D 1908.

Includes 7 new species in *Chaetostoma*, *Microlicia* (2), *Pterolepis*, *Itatiaia*, gen. nov., *Fritzschia*, and *Marcetia*.

Ule, E. *Violaceae.* [In Ule, Beiträge zur Flora von Bahia — I.] Bot. Jahrb. **42**: 230, 231. 29 D 1908.

Includes 2 new species, *Hybanthus procumbens* and *H. arenarius*.

Thornber, J. J. The viability of seeds. Plant World **11**: 158, 159. Jl 1908.

Theissen, F. Fragmenta bra-ilica. Ann. Myc. **6**: 531–535. 31 D 1908.

Includes *Phyllachora Goeppertiae* sp. nov.

Vries, H. de. Über die Zwillingsbastarde von *Oenothera nanella*. Ber. Deuts. Bot. Gesells. **26a**: 667–676. 19 D 1908.

Wangerin, W. *Cornaceae* novae — II. Repert. Nov. Spec. **6**: 97–102. 20 N 1908.

Weed, C. M. The study of the evergreens in the public schools. 1–30. Boston, 1908. [Illust.]

Wildeman, E. de. *Acanthostachys strobilacea* Kl. Icon. Select. Hort. Thenensis **6**: 87–90. *pl. 224.* My 1908.

Wildeman, E. de. *Serjania cuspidata* Camb. Icon. Select. Hort. Thenensis **6**: 97–100. *pl. 227.* N 1908.

Wilson, G. W. Notes on *Peronosporales* for 1907. Proc. Iowa Acad. Sci. **15**: 85–89. 1908.

Wolff, H. *Eryngium Buchtienii* Wolff nov. spec. Repert. Nov. Spec. **6**: 24. 1 N 1908.

Native of Bolivia.